JOURNAL

OF THE

AMERICAN WATER WORKS ASSOCIATION

The Association is not responsible, as a body, for the facts and opinions advanced in any of the papers or discussions published in its proceedings.

VOL. 1 DECEMBER 1914 No. 4

QUESTION BOX

Question 1: Do water meters increase or decrease cost of water supply to consumers?

MR. A. A. REIMER: We have taken the actual records of several hundred cases from our old flat rate system, and compared them with the same places under the meter system. We find that 71 or 72 per cent who go from flat rate to meter rate save money. On our side of the ledger we make that up from the other 28 or 29 per cent; so that we break even as a department; but over 70 per cent of the people actually save over the old flat rate.

MR. H. P. BOHMANN: When our flat rate was in force the owner of an eight room residence with modern plumbing paid about $15 annually. Under our metered rate the assessment is between $3 and $5 annually.

MR. J. N. CHESTER: In two or three plants where we have made investigation along this line the results have been that changing hotels, saloons and large consumers from flat to meter rates increased the cost of water to them. Another feature we worked out was that those families who had servants in the house generally paid more than those who handled their own spigots, and therefore believe that it depends largely upon the consumers. A community of working men's houses, unless your meter rates are minimum, or extremely high, cut down their water rent by putting on meters.

On the other hand in palatial residences, or even medium class ones, where they have servants in the house who are careless, and also fail to report leaky plumbing, etc., the consumer is going to pay more for the water metered.

MR. CHARLES F. BARRETT: In Salt Lake we gathered data as to some 285 domestic meters during the year 1913 and we found a saving of approximately 35 per cent. On a lot of saloons, rooming houses and apartment houses we found an increase on an average of approximately 20 per cent. On a number of industrial concerns we found the average rental very much higher and increasing.

MR. WIRT J. WILLS: As to whether the installation of meters decreases the price to consumers might be indicated from the fact that the people voluntarily asked for 8000 meters in the last four years. Up to recently we had no right to put a meter on unless the consumer asked for it. Most people have had experience with gas, electric and other kinds of meters, and are naturally prejudiced against meters; but after the 8000 had them in and got to talking around to their friends we have put in 2000 a year, the consumers voluntarily asking for them. The cost of that installation is charged up to construction of the plant. The benefit to the water plant is through the consciousness of knowing that most of the water is being paid for. There have been times in our life when we wanted to reduce the waste as much as possible. With this installation of 16,000 meters we now have a total of 25,000, and with the rigid inspection that we now employ we are furnishing per capita about 90 to 95 gallons per day, and are not pumping the same amount of water that we did ten years ago when the city was some 40,000 less than now in population. Metering has reduced the consumption probably 4 million gallons per day.

MR. E. E. DAVIS: There is only one answer to this question. Increasing the number of meters ought of course to decrease consumption. There is no question about that and it ought to decrease cost. When you decrease waste it certainly ought to follow that the cost is decreased.

Question 2: How is the cost of installation and maintenance of meters borne?

MR. E. E. DAVIS: Our meters are installed and maintained by the city.

MR. CHARLES F. BARRETT: The cost of installation is borne by the consumer at Salt Lake City.

MR. W. J. WILLS: We charge the installation to construction.

MR. J. N. CHESTER: The Public Service Commissions are putting the cost on the water companies or water departments.

MR. H. P. BOHMANN: By consumers. Although of the opinion that the principle is wrong, after the installation of nearly 60,000 meters, the speaker is afraid it is too late to make a change. If installed by Water Department fewer types and only the better ones would be installed.

MR. THOMAS HODKINSON: In Canada the municipalities are bearing the cost; and in our city the cost of installing a five-eighth inch meter is from $1.50 to $1.75 plus cost of meter. In case we put in an outside meter box it ought to be charged to the consumer according to the law, but that part of the law is a dead letter, and we bear the cost of the installation and maintenance, which is paid for out of revenue. The people at the present time are asking for meters. We charge 50 cents per quarter meter rent, with a minimum charge of 15 cents per 100 cubic feet. We give a 40 per cent discount for prompt payment. No discount is allowed off meter rent.

MR. C. W. WILES: From investigation of a large number in our vicinity we find that taking a flat rate on a house fully equipped it will run about $16 a year. The average by meter will run about $11 to $13; but we think that we save enough water to more than make up the difference in expense. As to the ownership of the meters the department should furnish the meters. It is a question whether they should charge rental to the consumer. That is optional; but in some places the department furnishes the meter and charges a rate sufficient to cover the cost and maintenance of the meter. The department should not maintain meters against frost or freezing; the consumer should pay the cost of that, because it is often due to his neglect that a meter freezes. The department should furnish the meters, and should charge a small amount, which should be

nominal, to maintain them in good repair. The ordinary domestic consumer will save over a $16 or $18 flat rate $4 or $5 every year by the use of meters, and on the other hand the department will save in consumption and wasted water.

MR. GEORGE F. COOPER: Will the gentleman please state what his meter rate is?

MR. C. W. WILES: Our rate is equal to 25 cents per 1000 gallons, but we abandoned the use of the term gallons some years ago and we now figure by cubic feet which saves us millions of figures in calculating. We charge 25 cents per 100 cubic feet less 10 per cent as an inducement to prompt payment, which is equivalent to 25 cents per 1000 gallons.

MR. C. FALLER: We sell water meters at their absolute cost to us. The minimum meter rate in certain classes of houses is so much lower than the flat rate for those houses that in the last two years the revenue derived from our water service has not been increased although there have been large extensions of water service.

Does not the answer to this question depend upon the relation the flat rate bears to the meter rate? One must know the schedule in each case; also the rules and regulations, and the class and habits of the consumers. No valuable conclusion can be reached unless the controlling conditions are set out. To answer the question abruptly as it is asked would not satisfy, since it would merely show a fact quite unrelated to other facts and conditions.

MR. H. HYMMEN: We furnish the meters. The consumer pays the plumber for installing them. Our rate is $1.13 a quarter net per 1000 feet. For excess over 1000 feet at the rate of 18 cents per 1000 gallons. There is a sliding scale running down to 6 cents per 1000 gallons, if they use over 10,000 gallons a day.

MR. H. C. HODGKINS: In the city of Syracuse they have reduced the meter rate to 12 cents per 100 cubic feet. The consumer pays for the meter. The department makes the repairs to the meters and charges the cost to the consumer. It ought to be self evident that the consumer will save by purchasing water at meter rates; but there is one other saving which the speaker can give to you in a nut shell.

The conduit line at the time of the first construction cost $1,000,000. Fifteen years following the installation of the first conduit a second one had to be built, at the cost of say another million dollars. These figures are not exact, but they are sufficient for the illustration. It is estimated that in 1925 an additional conduit or additional supply will be necessary. Four per cent on $1,000,000 means $40,000 a year saved to the tax payers; so that while the consumer saves from his water payment, the city budget is also saving a larger item in interest charges per year every year that another conduit is postponed due to the saving of water through meters.

MR. CHESTER R. MCFARLAND: We have both a flat rate and a meter rate. Under our contract we have an arrangement, or have a provision in the contract, whereby, if the consumer is dissatisfied with the flat rate, he can secure the meter rate by installing and maintaining the meter; or if we are dissatisfied with his consumption on the flat rate, we can install a meter at our cost and maintain it, and put him on meter rate. The result has been that although the people were dissatisfied for a number of years with the flat rates that were then established, we encouraged them to put on meters, and the introduction of the meters has had the result that instead of the criticism of the rates that obtained before, we are now receiving the commendation of the public because they are getting water for less than they got it before. It is proper that the flat rate should be much higher in proportion than the meter rate, because a man that takes water on an annual contract flat rate is going to waste it, whereas the man who takes it by meter is going to take care of his fixtures and reduce his consumption. We have found that where a man installed a meter it was very bad practice to have him take care of that meter and see that it was in proper working order, so that we have assumed the care of meters. The consumer pays for the first installation, and after that we pay all repairs, and if the meter for any reason wears out or becomes useless we install another meter at our cost. The consumer pays for one installation only. We are today operating about 1800 meters. We find the result very satisfactory. Our revenue is falling off in most cases where meters have been installed; but the falling off in revenue has been amply compensated by the saving in the cost of additional construction and in the consumption of water. We pump from wells and the securing of this water is expensive, so that we think it wise to keep down the

consumption and be paid for actually what we are serving. Our rate is 17 cents per 100 cubic feet. We do not use the term gallons because of the trouble in computing quantities; therefore we are using cubic feet as a basis, and 17 cents per 100 cubic feet is the maximum charge with a discount of 10 per cent. The first 5000 feet consumed in a month is charged at 17 cents; the second 5000 feet at 15 cents, and so on down to 9 cents for the large consumers. We have found that this is working very satisfactorily and that while our revenue is falling off in some cases, yet taken as a whole it is building up. Our consumption is only about 60 gallons per day per capita.

MR. W. C. HAWLEY: Mr. Hodgkins has hit the nail on the head. It is not a question merely of what the consumer saves on his water bill, but rather as to what is saved in the way of additional investment in the plant and in fixed charges on that investment. At Atlantic City some years ago the consumption per capita was from 250 to 260 gallons. After meters had been installed two years this consumption was cut down to 50 or 60 gallons per capita. We postponed an investment of more than a quarter of a million dollars for a number of years, and the saving in coal alone at the pumping station more than paid the cost of installing the meters. At the plant with which the speaker is now connected we are furnishing a large population just inside and outside of the city of Pittsburgh. We are on a meter basis exclusively or practically so. Our consumers are paying less at the rate of 20 cents per 100 cubic feet than the people in the balance of Pittsburgh who have corresponding properties are paying on a flat rate. Pittsburgh has a nominal rate of 18 cents per 1000 gallons or 13½ cents per 100 cubic feet, but is selling water to less than 10 per cent of its domestic customers by meter. In this case the meter rate is, doubtless, too low for the cost of the service, but when the city does go on to a meter basis, as it must in the not distant future, and has increased its meter rate to a reasonable figure, the great majority of those now paying on the flat rate basis will save money, and the reduction in waste will materially reduce the expense of operating the city's plant besides deferring large investment for increase in plant. This is a concrete illustration of the saving to be effected by the introduction of meters, and, as shown, the saving is not alone in the reduction of water bills but a material part is in the saving of investment which would be necessary if it were not for the meters.

MR. E. E. PARKER: We supply a meter for every service. We make two charges on our supplies; the first charge being a capacity charge, or the charge which we will make whether we furnish any water or not; the second charge is the output charge, or the cost of supplying the water used. The first charge on a five-eighth inch meter is $1.50 for six months. It represents the cost of maintaining the service, interest on investment, cost of reading meters, etc. The second charge is 6 cents per 100 cubic feet, and represents the actual cost of supplying the water.

MR. J. DAVIS BARNET: The speaker's experience coincides with that of a previous speaker (Mr. Hawley), that is, with an increasing number of domestic consumers the use of the meters has lessened the total daily pumpage. As the water works carries the whole cost of the equipment, it has it within its control as to what to buy and what to put into the house; and the speaker's railway experience having impressed upon him the value of uniformity of parts, he can say that since he has been on the Commission we have purchased but one type of meter. No consumer comes to us and says that the other fellow's meter is more honest than ours. We keep the very smallest number of parts for renewals, and it permits us to make changes and repairs very quickly.

MR. PATRICK GEAR: We do not have to pump water in Holyoke and we have comparatively few meters there; probably that is the reason we have adopted a flat rate for selling water. We sell metered water at a flat rate of 5½ cents per 1000 gallons, whether the consumer uses 1000 or 100,000 gallons. It will be hard to educate our people to a meter rate, because they have today in storage about 55,000 gallons for every man, woman and child in Holyoke, enough to supply us if we do not get any rain for a year. Our consumption is 105 or 106 gallons per day per capita. We furnish a meter on request to any building that contains four or more families. Our flat rate today is $6 a year per family and there is no limit to the number of fixtures. We charge $5 for each family per year for the metered water used, whether it is 5 gallons per capita or 10 gallons, up to 2,500 cubic feet of water every month per family. Anything over that will be charged for under the meter rate. We put the meter in and care for it ourselves. From the speaker's experience with meters he does not believe that if any man should come along and say,

"Here is a meter for $8, here is one for $12," that he would take the $8 one, because if you buy a good meter you are going to get the value of your money. We take care of the meters ourselves, repair them, test them, and keep them in order, and we charge for the meter 12 per cent of its cost for reading and care. The people who put in meters in tenement districts rather than paying by fixture rates are saving money in their bills anywhere from $10 to $15 a year if they take care of them.

MR. ROBERT ELLIOTT: We have something like 18,000 services, of which something over 15,000 are metered. We furnish the meter free and install it. We do not install services. We keep the meter in repair without cost to the consumer. We have reduced our pumpage something like 15 per cent in the last five years, and increased our revenues 25 to 30 per cent.

MR. OSCAR BULKELEY: Since 1910 Rockford, Illinois, has reduced the consumption per capita from something over 100 gallons, to 57 gallons last year. During that time every service has been metered. The actual saving to the people in their water bills has largely been concealed because of the fact that the flat rates and meter rates have quite generally been very unequitable. The saving effected by the meter would be very evident if our water rates, past and present, were based upon the true cost of service.

HENRY P. BOHMANN: Within the past year we succeeded in weeding out the last 1000 unmetered consumers. This was done for the benefit of the consumer who derives a direct benefit by reason of the reduction of the water bill and it is also to the advantage of the plumbers to put the plumbing of these people in first class shape; and it has had a very remarkable effect in the reduction of our pumpage. For five years prior to 1913 we had an average daily increase over the previous year of from 3 million to 6½ million gallons a day. This was cut down to 370,000 gallons daily average last year, and the increase in our revenue per million gallons pumped was $3.08. In other words, in 1913 we received $53,000 more for the same amount of water as compared with 1912. This shows that the general installation of meters is for the benefit of the consumer as well as the water company or department. Our rate is 4½ cents per 100 cubic feet. We have no minimum or service charge. We have 50,000 con-

sumers that do not pay more than $5 a year; 13,000 that pay $2 a year. This is only made possible from the fact that we have 100 large consumers that pay 50 per cent of the entire assessment; otherwise we could not afford to furnish water at the low rate. We have some that do not pay more than 50 cents a year. The speaker would recommend a minimum rate; still the people in the city of Milwaukee have been taught that the small consumer has the same rights and should get the same rates as the man that makes beer out of it.

MR. LOUIS L. TRIBUS: Until the last speaker named his 50 cents a year rate, the speaker did not suppose any citizen in the United States had the advantage over a small company in the west—which will not be named—in which the speaker has been interested for some years. Out of pure generosity of heart the company, a few years ago, allowed the people to put in meters at their own expense. Looking over some of the meter bills recently it was found that they have come down in some cases to as low as 19 cents per quarter. We shall soon have to go to the Public Utilities Commission of the State to ask the privilege of establishing a minimum rate; and we are going to put in meters.

MR. G. SHOEMAKER: At Waterloo we have 4600 consumers, 4500 being metered. The meter rate is 25 cents per hundred cubic feet. On the old flat rate the average bill was $15 a year. Of a list of 1917 consumers, who were changed from flat rate to meters, the rates of 97 remained the same, 1106 rates were reduced an average of $3.43 each per year; 714 rates were increased an average of $4.80 each per year, making a total decrease for the 1106 consumers of $3800.68, and a total increase for the 714 consumers of $3429.39; or a total loss on 1917 meters of 19.4 cents each per annum. In 1910, we had 3100 consumers, and our pumpage was 526,000,000 gallons per annum. In 1913 we had 4600 consumers and the pumpage was 490,000,000 gallons. The gentleman who just spoke, referred to a meter bill of 19 cents per quarter. An old book at Waterloo, containing accounts prior to 1904, shows that bills were collected at one and two cents per month.

MR. JERRY O'SHAUGHNESSY: Would like to say a word in regard to meters, and, of course, incidentally, advertise the progressiveness of Columbus, Ohio.

Years ago, we could scarcely pump the water as fast as the consumers used it. To overcome this strain on the pumps and to stop a considerable wastage of water that we knew existed, an arbitrary rule was made which increased the flat rate, on which basis the water rents were paid, 100 per cent. The people could take their choice of paying this amount or, by installing a meter, receive water at the rate of 6 cents per 1000 gallons with a ten per cent discount for prompt payment. The water delivered at that time was a filthy commodity to say the least; it seemed hardly fair to take the money for it. It should have been measured by the bushel rather than by the gallon. Later this condition was changed by the erection of a storage dam and treatment of the water by filtering and softening. It is not as easy for us to get good water as it is in the home of my friend from Holyoke. God has not favored us with pure water but makes it dependent upon us, with mechanical means, to procure it. However, the people took kindly to the change and put in meters. They did this too at their own expense. The speaker does not believe that this is the correct way to put in a meter system as he thinks the city should own the meters, but circumstances were such that we were compelled to do it at that time, and as a consequence, we have continued to sell the meters to the consumers. While the meter belongs to the consumer, the department maintains it without charge, except in the case of water freezing in it or its derangement having been caused by the carelessness of the owner.

We have over 30,000 active accounts in the water department and 93.3 per cent of the services are metered. In 1901, the superintendent of the water department reported that 21,000,000 gallons of water per day was being pumped. According to the 1900 census, Columbus had 126,000 people. In 1910, it had 182,000. For 1913, with the same ratio of increased pumpage, 17,500,000 gallons was reported as against the 1900 report of 21,000,000 gallons.

Columbus could not go back to the old way of selling water on the flat rate. If it did, we simply would have to impound more water and make provision, at an enormous expense, to meet the increased demand. The speaker really cannot see any side to this question but the meter side and he does not think anybody can conscientiously defend the flat rate system. Even if it is a place like Syracuse or Holyoke, with plenty of water, it is still an expense to get and deliver it.

MR. E. E. DAVIS: No city in the United States has experimented to any greater extent than Richmond, Virginia. We have the fourth water works that was ever built in the country; and, when it comes to the meter system the speaker does not see how any town can ever think of selling water by the old flat rate. Everybody was at first opposed to meters, because they said people would not use water enough to keep their premises clean, and that the question of saving waste was simply imagination on the part of the head of the water department. On one occasion, to test it, four houses were supplied from a one inch tap under 80 pounds pressure. Those four houses paid $11.89 every three months for water. Our rate was at that time 15 cents per 1000 gallons, with no scale. To demonstrate that something was going on the inspectors were not allowed on these premises for eighteen months, but in riding by in the car one could see water being used. A first-class meter was put on that tap to demonstrate to our city council that they were the people that were mistaken and not the water works people. The meter was started at three o'clock on the thirty-first day of July. On the thirty-first day of August, the meter showed that those four houses had used 456,000 gallons of water in just thirty-one days. The flat rates they were paying at that time were $3.38, $2.38, $2.88 and $3.25 per quarter. We have not had excess bills over half a dozen times in three years for either one of those houses. They are all getting water now for $2 for three months and using 13,500 gallons.

When we started allowing the people to purchase their meters and charging 25 cents per 1000 gallons for water, Mr. Green of the Southern Road said, "We cannot pay you 25 cents per 1000 gallons; we are only paying $100 per year for each locomotive running." I said, "How much approximately do they hold and how many times do you fill up your tenders?" He told me. I said, "Figure that up into the year and let me install a meter there for you and see what the difference is." That was at the 25 cents per 1000 gallons rate, a pretty high rate. So we figured it up and found that each one of his tenders used 2000 gallons. Some time after that we reduced the rate to 15 cents, and then his bill came down.

But the most important thing connected with meters is this abominable question of waste. They are kind enough at home to have confidence in the head of their department and let it be discretionary with him as to where meters ought to be put. A meter was put in

a saloon, and allowed to stay there for twelve months; the first month the bill was $5; the next quarter the bill was $2.50. At the start we made a meter charge of $2 a year. The courts decided that we had no business to charge rent for city property, so we abandoned that charge but we allowed the people to purchase the meters, paying 15 cents per 1000 gallons for all the water they used. It cost the city on the ordinary dwelling house with its necessary fixtures for the use of the premises, taking everything into consideration $6.35 a year to supply water into the tap. Then we made a minimum rate of $8 a year, which is $2 a quarter. We put a meter at a shoemaker shop and at the rate charged, being no minimum rate at that time, he paid $1.68 a year for his water. It was costing us $6.35 per year to maintain this supply. We had another case on the hill where a man found out he could let a stream the size of a straw run constantly into a barrel without the meter registering, and about every six months he paid us 68 cents. The fact was demonstrated that something had to be done. Then the Board of Health people began to come after us and said, "You should not introduce meters, because the people will not use enough water to keep their premises clean." Then we took up the question of a minimum rate, and introduced a minimum rate of $8 a year, which is in effect now. For larger places like hotels or other large consumers we do not add that minimum rate of $2 per quarter, but if such a consumer shuts down his plant and does not use any water we do not let him have it at any less than $2 per quarter. Several manufacturing plants had made connections without any evil intent, just to steal a little water. One man had a four-inch fire service besides his house connection. He had a meter on the other connection but he said he was getting his water for his boilers from a well. Another man dug a well 100 yards below him, and he reported his well was not giving the quantity of water it had. It occurred to me that if those wells were pretty close up the other fellow's must be suffering too. He had a connection to wash out his well every Saturday. On inspection we found that the well had been dry for the last six months. The owner said that he thought that the concern was paying for what water it got and he tapped the fire line. We sent him a bill for $338 and asked the firm to buy the meter.

Question No. 3: Experience with lead or tin lined iron pipe; comparative efficiency, life and cost?

MR. P. GEAR: At the meeting of the New England Water Works Association held in March last, a gentleman from Boston made the suggestion that you could clean out all services of iron pipe with a hand pump, by going into the cellar, disconnecting the pipe there, making a little ball of tissue paper, and forcing it through the pipe. The speaker tried that method when he got home, and found that it did clean out services that were in pretty bad condition; and he also tried the method on five or six services that were anywhere from 35 to 40 feet long, and found that it worked all right, except on services which were in very bad condition. Those it was tried on were old galvanized iron pipe. You would hardly think that anybody could do it, but it can be done. It will work in an elbow of 45 degrees. It will go through lead pipe, or any other kind of pipe, if you give it time. A pail put under the services would take about three or four minutes to fill, which would be filled after the services were cleaned in six or seven seconds. It is very handy for cleaning out services in paved streets where you do not want to take them up. A man whose house stands back 30 or 40 feet from the street will be delighted to find that you can make such a great improvement in the condition of the service pipes without being compelled to dig up the lawn. Open it up inside of the wall line and attach your pump there. If the full results are not obtained the first time of making the trial try it again. After you run up to 50 or 60 pounds pressure you can drop off and relieve it some. If you were to run up to 250 pounds, you would be liable to break the pipe. When the normal pressure was 75 pounds the speaker has run the gauge up to 150 pounds, giving it time to make itself smaller and go through. There is another machine gotten up by a man in Massachusetts, who takes a drill and sets it up in the cellar in order to clean out the service, making it as good as ever. He has rods connected 100 feet long. That, however, will not go around any bend.

SECRETARY DIVEN: Are the rods not flexible?

MR. P. GEAR: Yes, but you are liable to get stuck and leave part of the rod in the pipe. If it is a straight run from the cellar out to the main, you could go straight through, and clean your services out so that they will be as good as the day they were put in.

SECRETARY DIVEN: You can relieve the pressure on the force pump by opening a nearby fire hydrant to give relief, doing away with the

back pressure. This has been done where we could not clean the pipe out with the pump otherwise.

MR. CHARLES S. POTTER: In Louisville, instead of using the method as suggested, we uncouple at the ferrule and insert rye bread then connect and open ferrule, also faucet in kitchen, we carry 65 to 75 pounds pressure and find it sufficient to quickly and thoroughly clean any lead service pipe.

Before making renewals or enlargements, on complaint by consumer of lack of pressure, we use this method, and in many cases are able to save cost of new service.

PRESIDENT THOMAS: Do you force that through under pressure?

MR. CHARLES S. POTTER: Yes, frequently we find the people ask to have services enlarged when if the services were cleaned no enlargement would be necessary.

PRESIDENT THOMAS: Mr. Gear says that with the method described by him they do not have to take up the pavement.

Question No. 4: What is the best method of making temporary repairs to pavements torn up for water works construction or repairs, putting in services, etc?

MR. H. P. BOHMANN: If the ditch is dry and earth well tamped concrete and pavement can be replaced immediately. If the ditch is wet replace earth and put loose crushed stone on top and allow the ditch to settle before concreting and restoring pavement. In all cases concrete should extend 8 inches beyond the width of trench.

MR. J. M. DIVEN: No matter how carefully dirt is put back in a ditch, or how thoroughly it is rammed in, on paved streets, passing vehicles will work it out, leaving a hollow. To avoid this the speaker has mixed the top layer, to a depth of 6 or 8 inches, with cement, using the cement in the proportion of one to seven or eight of gravel. This has made a filling not easily or quickly displaced by passing vehicles—a filling that has lasted until the pavement was permanently replaced.

With pavements having a concrete base, the speaker has beveled the edges of the old concrete, so that the patch acted as the keystone

of an arch, or went in as a wedge, making the patch somewhat thicker than the original concrete foundation, and bringing it only to the top of the old concrete, then, as a temporary surface, filling in with cement mortar, one part cement and three parts sand, up to the street surface, first putting a sheet of tar paper over the concrete base, so that the top finish can be easily removed when the permanent surface is put on. This has been found a very satisfactory way of making temporary repairs, the cement mortar making a smooth surface and one that will last for several months if necessary, yet may be easily removed when the pavement repair gang comes along. In the smaller towns it is usual for asphalt pavement repairers to come around once a year, so that some fairly permanent repair job is necessary for asphalt streets. There is a cold asphalt surfacing material on the market, but the speaker has had no experience with it.

MR. OSCAR BULKELEY: In Rockford, where we have brick pavement with concrete base to take up, we first fill the trench, tamp the dirt thoroughly, then place the brick immediately upon the top of the dirt. It is then left for a period of a week or ten days until the trench settles, after which a concrete base is laid with the brick on top. For asphalt cuts the concrete base is placed with paving brick on top. In our city the street department takes care of the asphalt cuttings of that kind at a regular time each year. The brick pavement merely takes the place of asphalt for a year or less.

MR. J. M. DIVEN: Is not that rather unsightly?

MR. OSCAR BULKELEY: A little bit, but it is better than leaving a hole in the street.

MR. MORRIS R. SHERRERD: Our practice has been to put in sewer, water and gas connections, for every lot, vacant and otherwise, before a street is paved.

MR. J. M. DIVEN: That does not solve the problem, often a service of a different size or in a different location is wanted when a building is put up.

MR. MORRIS R. SHERRERD: No, but it reduces the cutting of the pavements to a minimum.

Question No. 5: Should private fire services be shut off, in case of fire in sprinkler protected buildings, as soon as the fire department reaches the fire and is in action?

MR. H. P. BOHMANN: No. It would be dangerous to attempt to shut off a valve in the street while the department is fighting a big fire.

MR. CHARLES H. SMITH.[1] The automatic sprinkler is the most effective agent known for the extinguishment of fire. Its efficiency is shown not only by the number of fires extinguished in their incipiency by from one to a dozen sprinklers but also by the many fires which are held in check by the sprinkler system even though for various reasons the first sprinklers which open are not able to fully extinguish it.

The experience of the Factory Mutual Fire Insurance Companies furnishes a striking illustration of the value of sprinkler protection. While today the factories insured in this system are completely sprinklered and their general fire protection has reached a standard of excellence not exceeded by any other class of property in the United States, yet their beginning was in the days before automatic sprinklers were invented and at first these properties were simply protected by private hydrant systems, hose standpipes, and the like. After the invention of the automatic sprinkler in 1875, sprinklers began to be introduced into these factories. During the ten year period from 1877 to 1887, it is estimated that not more than one-quarter of the property thus insured was equipped with automatic sprinklers. For this same period, we had 759 fires without automatic sprinkler protection, with an average loss per fire of $7500, and 206 fires with automatic sprinkler protection, average loss $1080, showing an average loss per fire without sprinklers seven times as great as that where there were sprinklers. Naturally, in those days the sprinkler systems were somewhat crude and not so effective as they are today.

The General Fire Extinguisher Company keeps a record of fires occurring under their sprinklers and their *Bulletin* of April, 1914, relates that up to that date 13,678 fires in America have been reported. Of these no claim for insurance was made on 8213, and on the remainder, 5465, the average loss per fire was $267.22.

[1] Engineer and Special Inspector Associated Factory Mutual Fire Insurance Companies.

The National Fire Protection Association has gathered the statistics of fires in properties having automatic sprinkler protection since the organization of the Society in 1897. From 1897 to 1914, 14,714 fires were reported in sprinklered risks. Of this number 95 per cent are classified as satisfactory fires, that is, where the fire was either extinguished by the sprinklers or held in check by them; 63 per cent of these fires were practically or entirely extinguished by the sprinklers and 32 per cent held in check; 85 per cent of the whole number of fires were controlled by 12 sprinklers or less, and the number of cases where over 100 sprinklers opened was but 2.7 per cent.

SAFEGUARDING HUMAN LIFE

So much for the automatic sprinkler as a protection against property loss, but it has a function beyond that which up to date has been little appreciated. Industrial establishments protected by automatic sprinklers have been almost free from loss of life by fire. Since the inception of the Factory Mutual System in 1835, there have been but thirty-six lives lost in fires in our factories and twenty-one of these were in an unsprinklered mill in Fall River in 1874 before sprinklers were generally installed. So that during the last forty years, since the introduction of sprinklers, there have been but fifteen lives lost by fire in these factories, where there are now employed at least a million and a half people every day.

DANGER OF THE CLOSED VALVE

The automatic sprinkler cannot perform its function without ample water supply. Given a proper installation of sprinklers and excluding a few examples of special hazard, the cases where fire has progressed beyond their control are due to either one of two things, namely, the valve controlling the sprinkler system was shut at the start of the fire, or the sprinklers were shut off too soon. Closed valves we are constantly trying to guard against, not only by our quarterly inspections, but also by stimulating owners to rigorous self-inspection. In cities, automatic supervisory service of fire apparatus by the telegraph companies has been inauguarated to the same end.

That sprinklers may not be shut off too soon during a fire, a feeling of confidence in what the automatic sprinkler is able to accomplish

must be established. It is not strange that people not familiar with sprinklers may feel somewhat sceptical as to the final outcome at a fire which has filled the room with smoke, and immediately think it necessary to resort to hose streams, believing that water used otherwise is being wasted. Experience teaches, however, that if a sprinkler equipment is amply supplied with water, you may feel reasonably sure that the fire will be taken care of.

Good judgment is certainly required that the sprinkler system be not shut off too soon. Sometimes those in charge, believing the fire to be extinguished, have shut off the system prematurely, with the idea of preventing further water damage. Events showed, however, that the fire had not been completely extinguished, and gaining headway with the sprinklers shut off, a considerable loss occurred before the fire was brought under control.

QUANTITY OF WATER USED BY SPRINKLERS

The automatic sprinkler works at the seat of the fire and commonly performs its work with the use of very much less water than would be needed, were hose streams entirely relied upon. The discharge from a sprinkler, of course, varies with the pressure, but on an average it may be taken at about 20 gallons per minute. We may therefore figure that 12 sprinklers would discharge 240 gallons per minute and protect floor space of about 1200 square feet with practically the same amount of water that would be used by one hose stream, with a $1\frac{1}{8}$-inch nozzle, which at the lowest effective pressure would discharge about 250 gallons per minute. While not wishing to belittle the hose stream as a secondary line of defence, there is no doubt that a large part of the water used by hose streams in fighting fire is actually wasted, and worse than that, large and unnecessary water damage inflicted in some cases.

This fact is becoming generally recognized and it is now the order in some of our large cities, notably New York, Philadelphia, Chicago, and St. Louis, that the fire department on arriving at a fire shall couple up either the first or second stream to the steamer connection to sprinklers when such exists, in order that the sprinklers may have the benefit of high pressure from the steamer in the early stages of the fire. In New York it is compulsory to provide such steamer connection when installing a sprinkler system. This matter is of immense importance in high city buildings as the highest pressure hose streams will not reach above the sixth floor.

CONTROL OF SERVICES

With sprinklers well supplied with water, the cases are rare where fires gain such headway in a sprinklered building as to cause sufficient destruction to seriously cripple the system and waste water from broken pipes. From the statistics quoted at the beginning of this paper, such cases would amount to 2.7 per cent only of the whole. That even this remote contingency may be taken care of, we in our work always arrange to control the supply to sprinklers in the building by a safely located outside indicating valve. Primarily, however, the reason for an outside controlling valve is that when it becomes necessary to shut off a system for legitimate repairs, we may be able in case of fire to turn water into the system without the necessity of going inside the building.

In considering the possibility of waste of water in buildings on fire, there is very much more to be apprehended from the breakage of pipes entering unsprinklered buildings for domestic supply or for the supply of elevators, etc., which commonly do not have the valves controlling them conspicuously or safely located, and more wisdom would be shown in demanding that accessible valves be placed on such service connections.

Decidedly the fire service to a building equipped with automatic sprinklers should not be shut off as long as the building is intact; and if the automatic sprinkler equipment in that building is properly supplied with water at the start of a fire, that means that rarely will it be necessary to shut off the equipment until the fire is extinguished. The first duty of those in control of water supplies at a fire should be to see that water is *surely on* the sprinkler equipment rather than to turn it off. To do otherwise in the early stages of a fire is to spike your guns on the eve of battle.

MR. J. M. DIVEN: Until recently the speaker firmly believed that sprinkler services should be shut off as soon as the fire department took charge at a fire, but, while watching a fire in a sprinklered building recently, he realized that the sprinklers were in action in parts of the building not reached by the hose streams. The automatic sprinklers were not hampered or confused by smoke, but always put the water where it was needed. Of course there should be someone present to shut off the sprinklers when the building begins to fall, or falling floors break the sprinklers; also the sprinklers should be

shut off when their draft lowers the pressure enough to cripple the fire department service. But, while there is plenty of water for both the sprinklers and the hose streams, the speaker is firmly convinced that the sprinkler service should be left in action while the building is intact, or while there is any chance of saving it.

MR. P. GEAR: The paper read by Mr. Smith on the shutting off of private fire service was well prepared. The speaker does not believe in the shutting off of private fire services. The insurance men and firemen are the parties who would have to settle that question. When the firemen are called out to fight a fire, they are supposed to have full control over it. The speaker has never known where any harm was done to a water service, in our city, owing to the water not being turned off. It would seem that it is not a very good idea to turn off the water from a mill, where there are sprinkler heads in places where the firemen can not reach the fire, but if the water is allowed to run it may do some good. It might be well to let the water run but shut off the gas.

MR. C. H. SMITH: The gentleman from Holyoke has not, in the speaker's opinion, taken sufficient credit to himself, so he would like to say a word as to what he believes to be the custom in Holyoke, understanding that at every alarm of fire there the Water Department sends out a man to make sure that the water supplies to fire services in the mill yards or buildings are free and unobstructed, and that the street hydrants are properly supplied; that is, if there are any valves improperly closed, it is his duty to see that they are opened.

MR. W. H. RANDALL: Some time last fall we had a very serious fire in the city of Toronto, and the firemen on arrival at the fire connected up to the fire hydrant. When the first stream was put on apparently the pressure was all right; but they connected four streams, and the pressure was all wrong, notwithstanding the fact that our high level pumping station and everything else proved to be normal. This became a very serious question in the city of Toronto with regard to the pressure of water. Since then, we have adopted this system: every fire alarm that comes in, whether it is night or day, a gong rings in the office and men are tolled off to answer the call. It is their duty to go to the fire and see that the pressures are taken with gauges and taken from hydrants not in use, circling the

fire district. Since adopting that plan, we have never had any complaint of any lack of pressure as far as the water works department is concerned.

Question No. 6: Experience with annoying noises caused by working of water meters?

MR. H. P. BOHMANN: Sometimes caused by a broken meter disc. In several instances we found the cause to be iron pipe carried overhead.

MR. A. A. REIMER: We have had quite a number of complaints of noisy meters, and in fully nine out of every ten cases we find that the fault is not in the meter direct, but is due to the faulty construction of the piping system in the house, which simply acts as a telephone or vibrator carrying the noise all over. When we get complaints of that kind we send a man to investigate. He puts a few pieces of felt between the pipes, and then there is no more trouble from noisy meters. In the few cases where the noise is directly attributable to the meter, we find that something has gone wrong usually in the gearing, which allows more play than there should be to the working parts.

Question No. 7: What is the correct or best way of testing water meters? Is it practical to test meters, especially large sizes, in place?

MR. H. P. BOHMANN: By running a definite amount of water and weighing same. Large meters can be tested best on premises with a test meter if a testing tee is inserted between the outlet side of the meter and the outlet meter valve.

MR. WILLIAM VOLKHARDT: All meter manufacturers test small meters by weight. Get a good reliable scale and weigh the water, so that you will be less liable to err. Large meters may be tested in place, although the best practice is to send them to the testing plant.

Question No. 8: Experience with straight line reading meters—are they preferable to the clock dial meters?

MR. H. P. BOHMANN: Clock dials are less apt to get out of order as all gears are in constant motion. In a straight reading dial the higher reading hands are idle too long and often corrode.

MR. WILLIAM VOLKHARDT: If you have a straight reading meter you eliminate the mystery, and may place the entire responsibility of the meter bill upon the consumer. If the consumer complains of a large bill, you can take the position that you have no control over his or her personal affairs, as it is the duty of the consumer to make periodical readings and keep track of the consumption. This position you cannot take very well if you furnish a round dial meter, because you all know it is difficult to read.

MR. J. DAVIS BARNETT: This question brings up the matter of the man engaged and not the machinery; for there is a possibility of error in reading the dial gauge, which there is not in the straight reading meter. That was once brought home to the speaker, because he remembers that one of the first things in connection with water works that he did was to sign a refund check for $1100 for a reduction on bills that had been made up on dial readings, furnished month after month jointly by an employee of the water works and of the company that was receiving the water. That shows how long an error can continue. Since changing to straight reading meters, there has been no complaint and no cause to believe that there was a misreading of the straight line register.

MR. W. R. YOUNG: With reference to the straight reading meter and the statement by a previous speaker that they never find any mistakes in reading such meters, we have in Minneapolis 46,000 meters in service, about 45,000 of which are round dial. Our men are all hired by the month, and they work twelve months in a year. They become as conversant with the reading of that type of meter as any person does with regard to telling the time of day by an ordinary clock or watch. That is the case, no matter whether the face of the meter by the action of water and chemicals is entirely obliterated. The readings of the meter are nevertheless taken with considerable accuracy and are found to be practically correct. But with the straight reading meters we have had more or less trouble. We have had considerable trouble with figures becoming obliterated on the straight reading meters; but we feel that if our inspectors are

instructed properly they will read the dial reading meters just as well as they could tell the time of day by the hands on a clock.

MR. C. W. WILES: The most serious objection to the straight reading meters has been that the last counters become corroded and stick, as they move so slowly; the gears stick before you have a chance to use them at all. We have had to send them back to the factory on that account. The meter manufacturers, themselves, will tell you that that same question has given them a great deal of concern.

MR. GEORGE HOUSTON: The last speaker is probably using a meter that has not the proper kind of register in the straight reading meter, or he would not have that corrosion or sticking that he mentions. We have about 7000, and with some makes we have never had any trouble of the sort described. The speaker is prejudiced in favor of the straight reading meters, because he feels that the round dial has no excuse for existence. One man does all the reading of our 7000 meters, and we are satisfied that one man will do at least twice as much in the line of turning in reports on straight reading meters as he will on round dials. Scarcely any mistakes are made on the straight reading meters; whereas on the other kind we have had mistakes that caused a great deal of trouble, and many of them. Anybody who has anything to do with reading meters knows that many times the people are not at home, so that the meter reader fails to get in and get the reading. Our men have sometimes had to go back four or five times on this account, which necessitates an enormous amount of travel. That, too, adds to the cost of reading the meters. If a meter reader finds that the lady of the house is not at home, he can leave a memorandum, if there is a straight reading meter in the house, requesting her to send the reading in to the office; but if it is a round dial the lady cannot do this so well. This system gets them in the habit of reading the meter, and they will telephone the reading in themselves, saving your men the trouble of going back again. Taking it all together, we save thousands of miles of travel for our meter readers by using straight reading registers, and are able to collect our bills more regularly than we could if we used the round dials.

MR. W. H. RANDALL: You say that you have 7000 meters, and that just one man does the reading? How often are the meters read?

MR. GEORGE HOUSTON: Yes, one man reads them all every quarter.

MR. W. H. RANDALL: Is that the custom in the United States, to read quarterly?

MR. GEORGE HOUSTON: That is the way we have been doing for the last 10 or 15 years at Kalamazoo.

MR. WIRT J. WILLS: If the gentleman can get one man to read 7000 meters, the speaker will have to revise his opinion, which has not been in favor of the straight reading meter. We have 16,000 meters and 12 men reading them, evidently something wrong with us. The reason that the speaker objects to straight reading meters is, as a previous speaker said, that they are apt to become corroded and the dials turn very slowly. We have discontinued them on that account.

MR. EARL W. KELLY: Our method of obviating the difficulty, in case the meter reader does not find anyone at home, is this: We furnish the meter reader with a little printed card to the effect that the meter reader has called and found no one at home, with the request that the party fill out the reading on the card. On the back of the card is printed a facsimile of the dial of the meter, and the consumer simply marks in pencil on each dial the position of the corresponding hand on the meter dial.

MR. GEORGE HOUSTON: The round dial meter would not be so bad, were it not for the fact that on some of the meters each hand revolves in the same direction, while in others, every other hand travels in an opposite direction, which is confusing. Some of our men who have been in the service seventeen years we find will make about as many mistakes reading the round dial meter as a green hand; so how can you expect a novice, particularly a lady who has to go down cellar to do it, to read a round dial meter with the same accuracy that she would a straight reading meter? We have in the neighborhood of 6000 straight reading meters, of all kinds, and on an average of not more than three of those meters stick in the upper register during a year. We have never had any of one company's make stick, no matter what kind they were, for the reason that the shaft

on which the counter tumblers revolve moves every time a fractional part of a foot of water goes through and keeps the bearings perfectly limber so that they cannot stick. Examine the different makes, and you will find that some of them cannot stick.

MR. THOMAS HODKINSON: With regard to what Mr. Young said, we have had the same mistake occur with one of our meter readers. It is very easy to read the units in place of the tens. In one year in the case of one large consumer there was a difference of $1000. With regard to the clock dials, we find that we can educate a man to read a clock register correctly in about two days. We break them in to read about 100 meters a day; that is about all they can do, and it keeps them going for nine hours. We have had straight reading registers stick. With regard to the shaft turning around, there is more than one kind of a register; some have the shaft stationary. Some of the meter manufacturers are making them that way now; but they have been making them where the cogs move around on the shaft, and where the consumption is small, they corrode; this causes them to stick.

MR. A. A. REIMER: What kind of territory did the previous speaker have to cover? He spoke of his men reading 100 meters a day. Is his territory scattered so that the meters are far apart?

MR. THOMAS HODKINSON: No, they are close together, but there are very few put in on the streets. Nearly all are put in the basements.

MR. A. A. REIMER: It seems as though you are getting a very low figure.

MR. THOMAS HODKINSON: If our meter readers notice a large consumption they locate the reason for such and if there is a leak the consumer is notified right on the spot to have it repaired. This keeps down any complaints which may occur when the bills are rendered.

MR. A. A. REIMER: We are getting 125 to 150 from our meter readers, over scattered territory. It sounds like a very low figure when you say 100 a day.

MR. W. H. RANDALL: The gentleman from London says that his readers are practically inspectors as well as readers. They go through the premises to find out leaks, and thus are practically doing the work of inspectors.

MR. A. A. REIMER: The object of the meter is to put an automatic inspector on services. It seems as though you were going to an unnecessary expense when you put a human inspector on with an automatic machine inspector.

MR. THOMAS HODKINSON: We usually do that to keep down complaints, and keep our metered consumers better satisfied.

MR. CHARLES S. POTTER: We thoroughly tested four different makes of meters equipped with straight reading dials. With the exception of one type of meter, results obtained were unsatisfactory, and we have discontinued using the straight reading dials. The speaker is anxious to get some information as to the reading of meters. Our city has approximately 40,000 services, only 10 per cent of which are metered. They are, therefore, badly scattered over the city, but are placed on the sidewalk and are accessible at all times. We are unable to read more than an average of 150 meters per day.

Regarding complaints, we find it advisable to investigate unusually large consumption at the time the meter is read instead of waiting until complaint has been made by the consumer.

Question No. 9: Legal decisions concerning "Averaging rate" when meter is out of order and not registering?

MR. CHARLES S. POTTER: About six months ago, a decision was rendered in the Jefferson Circuit Court of Kentucky along that line.

A meter that had been in service approximately twenty years, was removed, and a new meter installed.

The Court ruled that the plaintiff would not be permitted to introduce any evidence regarding previous readings as shown by the old meter; in other words, the reading of the new meter, which was proved to be accurate, must be taken, regardless of past averages.

This case is now in the Court of Appeals.

MR. ROBERT A. JACKSON: We had a case like that. We took the previous three years' quarterly statements, added them together, and divided by 3, and rendered the bill on that basis. The consumer objected to that, and we said, "All right, we will let you go on for three months and we will render a bill on that basis." What did he do? Why, he did not use any water at all, and he said that he had not used any in the previous nine months.

Question No. 10: Possibility of and conditions governing over-registration of meters?

MR. H. P. BOHMANN: Velocity type of meters sometimes over-registered when meters get clogged.

MR. J. DAVIS BARNETT: Quite recently the mechanical engineer of a very large company appeared before us and claimed that an eight-inch meter running steadily at 80 pounds pressure can over-register to the extent of one-third of a million gallons per day. We would not accept his claim in that case. If anybody has experience as to over-registration or over-running of meters, would like to have him give his experience.

Going back some thirty-five or forty years, almost too long to give all the details of the matter, and referring to a communication in *Engineering* of London, England, which mentioned a case where a pipe was cut and a meter inserted. There was a long system forward of the meter, with a long dead end not in use. The whole length of this pipe acted as an air chamber, with the result that when the water was turned on it flowed through the meter and backed up the air, and afterwards (when shut off) the air quietly recovered without unwinding the register. That is the single case within the speaker's knowledge. In the case previously referred to, where it was said that we were over-registering one-third of a million gallons per day, there happened to be a shut-off valve just forward of the eight-inch meter. We tapped the pipe, put a small meter in, and let the water escape through the small meter, and the difference in readings between the two meters was only 1 per cent.

MR. P. GEAR: We had a little experience this year with a meter. We always told manufacturers and consumers that this particular make of meter would not over-register and will have to apologize to some of them. There is a sixteen-inch meter on one of our main

lines coming from our reservoir. Two of the four lines supply part of the residential portion of the town. One comes down town regulated by a valve. We had a suspicion that there was something wrong with this meter on account of the amount of water that it was registering as coming from the reservoir and the amount of water that was left in the reservoir. From our calculation of the amount of rainfall and the amount of water in storage in the reservoir, we suspected something wrong, but we did not discover what it was until along in the fall of the year, when, business being slack, we went around looking for trouble. Our consumption did not go down in the winter, as it ought to have done. We shut off the meter that supplied 5000 people in the upper section of the city. It was showing a consumption of nearly 800,000 gallons a day for the residents of that section, which seemed too large. We found a two-inch plank seven inches square in the throat of the large meter which put more than the proper proportion of the water through the small one. When the obstruction was removed the meter showed a consumption of 350,000 gallons where it had been showing 800,000.

MR. C. W. WILES: The speaker has offered consumers oftentimes to take out and test their meters, and if they over-registered 2 per cent to give them the amount of the entire bill, and has never been caught on it yet; but did learn of one meter in Michigan some years ago that showed an over-registration of about 25 per cent. What do you suppose was the trouble in that case? They found that the assemblers at the factory had put in the wrong spur wheel on top; that was all there was to it and that was corrected. The speaker has never heard of a small meter that over-registered; but they will under-register slightly when they are new.

MR. J. M. DIVEN: On complaint of over-registration of a four-inch meter, it was taken out, tested, and found to over-register. It was then sent to the factory to test and repair. The explanation of the over-registration was that the meter was very dirty, and that the over-registration was caused by the reduced area of the measuring chamber, due to the accumulation of sediment in it. This was a disc type of meter. The moral of this experience is that, when using turbid or highly corrosive water, the meters should be cleaned often. However, cases of over-registration are few as compared with under-registration of worn meters.

MR. CHARLES S. POTTER: Our department in the past has also offered to give the consumer the amount of the bill if they could find that the meter was over-registering. Recently we found it advisable to discontinue this offer, for out of 110 meters, three, four and six-inch, velocity type, purchased two years ago, about 50 per cent, after from six to eight months' service, have over-registered from 3 to 11 per cent. The engineering force sent by the manufacturer reported that the over-registration was due to a peculiar vegetable formation which adhered to the rubber piston. This slight deposit varying in thickness from one sixty-fourth to one thirty-second of an inch caused a slight reduction in area of the helical blades. When the meters were taken apart and thoroughly washed, they would drop back to accuracy in registration.

MR. W. J. WILLS: We do not guarantee plunger displacement meters very much, but in our city if a meter is fast, we offer to give a suit of clothes; we have never had to give a suit of clothes yet, but came very near it. The water in Memphis is impregnated with iron, not dirt, but iron sediment. Little particles of iron adhering to the working parts of the meter reduced the capacity so that, although it was 5 per cent slow five years ago, when we tested it out it was 3 per cent fast. There was a difference of over 7 per cent in a little over five years.

MR. WILLIAM LUSCOMBE: We had a single case in Gary, Indiana. About three years ago we had a case of a meter that over-registered about ten times the water that passed through it. This was due to a mistake in placing a register and combination gears for a large meter on a small meter. We had a refund of about $500 to make to the consumer.

MR. W. H. RANDALL: The speaker devoted a great deal of time to the study of meters some years ago, and gave some of them very severe tests. We had one on what was known as "Foresters Temple" in Toronto for seven years, a type of meter that is not common in this country. The impeller has wings on it, which govern the rate due to the velocity with which it travels. There was a dispute with regard to the consumer's bill. The meter tested within one per cent notwithstanding the fact that it had been on for seven years. The bill was settled, and everything was satisfactory. After the

settlement was made, we had the meter taken apart, thoroughly cleaned, and put together again. Nothing was done to it otherwise. After cleaning we put it through the same test, and it was found to be 5 per cent fast; showing quite clearly that the meter, being of the velocity type, but dirty and sluggish, was not fast while in service; but after cleaning it showed quite clearly that whatever little particles had stuck to the side of the cylinders where the impeller ran had worn off the wings to such a shape that after it was cleaned out and put in shape again it was necessary to spread these vanes out more, to make it come back to its proper recording condition.

MR. A. W. CUDDEBACK: There is one type of meter which is probably ahead of any other in the possibilities of over-registration. This is the current meter, and the excess registration may be 4 to 5 per cent up to from 40 to 50 per cent. In the cases examined, and we have had several, the cause of the over-registration was found to be due to the choking up of the port, increasing the velocity of the vanes. That type of meter needs continual watching. By testing twice a year we generally catch these little differences. In one case the over-registration was as much as 40 per cent, due to the choking up of the port. In regard to the domestic or ordinary disc meter, we have never had an over-registration of more than 4 or 5 per cent, and this was undoubtedly due to a slight coating of the disc chamber. The current meters need careful watching in order to secure continuously correct registration.

MR. WILLIAM VOLKHARDT: If this discussion on over-registration of meters is printed it might lead some to believe that all meters over-register, and it is not the intention of the members of this Association to give out that impression. There have been a lot of things said here that it would be well to keep out of print, because each speaker has described a reason for the over-registration due mostly to an accumulation in the meter, or some similar cause. Summing up the entire discussion, the percentage of over-registration is infinitesimal compared with the number of meters in use. The house type of meters as a rule do not over-register. If we are going to infer that they do, am afraid you will get into lots of trouble.

MR. W. J. WILLS: On an average we take out on account of running slow 150 meters a month, from a total of about 16,000. In some cases they absolutely stop all movement.

MR. A. A. REIMER: In connection with the fact that the trouble with disc meters is under-registration on small streams, we issue a pamphlet to our customers, in which we not only try to teach them how to read their meters, but also make a plain statement like this: "The meter placed in your house is as accurate as an ordinary watch." And we stand back of that statement too. We have had to take out hundreds of meters to test them on the application of the consumer, for which we require a deposit of $2, with the understanding that if the meter is found to be fast 3 per cent or more, the bill will be adjusted. If not, we keep the $2. We have never as yet had to give the $2 back; in fact, we advised our consumers not to call upon us to make a test, so sure are we that the meters will not over-register.

Question No. 11: Should meters register cubic feet or gallons?

MR. A. P. FOLWELL: In some data collected on meter readings, out of 285 cities 210 show the records in gallons, 75 in cubic feet. This is presumably a large enough number of cities to give a fair idea of the general practice, it would seem.

MR. J. M. DIVEN: There is one advantage in the gallon method of registration; the ordinary consumer who makes a complaint and wants his meter tested knows what a gallon of water is, and does not know very much about cubic feet. In making tests it is an advantage to have meters read in gallons. It also saves some work in the office, in making out bills.

MR. C. W. WILES: Reading meters in gallons is a very cumbersome method and the trouble connected with reading meters would be multiplied if you figured them all by gallons. The speaker prefers cubic feet, and believes that the dials are more easily and quickly read under that method. For the last few years we have used cubic feet instead of gallons. Our original rate was 25 cents per 1000 gallons; but is now 20 cents per 100 cubic feet. It was found that 20 cents per 100 cubic feet, less 10 per cent, was practically equal to 25 cents per 1000 gallons, with a slight difference in favor of the consumer. It works very satisfactorily indeed, and eliminates all the trouble that you will have if you work it out by gallons.

With regard to the small disc meter, the longer it is in use the more water it will slip. The disc is wearing all the time, and the gears

also wear, consequently more water comes through the meter than ought to after it has been in service four or five years.

MR. A. A. REIMER: The speaker would like to say a word about dial meters. The figures Mr. Folwell has given us are surprising. The consumers in this country in cities where gas is in use do not know anything about a gallon of gas, but they do know that they are charged so much per 1000 cubic feet of gas, and if they use electricity they are charged by the K.W. hour; but they do not know what it means in ninety-nine cases out of a hundred. There is a tendency, not any too strong as yet, but the tendency nevertheless exists, toward the use of the metric system in a great many kinds of work. The time will come when we will discard cubic feet as well as gallons, and we will have the cubic meter, or kilometer or cubic centimeter, or something like that.

MR. WILLIAM LUSCOMBE: It seems a common sense proposition that if water is sold on a basis of cubic feet that the cubic feet registration would save a great deal of figuring by the clerical force in arriving at the amount of the bill; whereas if it is sold on a gallon basis, the gallon registration would be preferable.

Question No. 12: How should house hot water boilers be cared for when water is shut off; what instructions should be given to occupants of houses?

MR. H. P. BOHMANN: If boiler is supplied directly from the main, keep up only moderate fire, and open hot water faucet, and shut the cold water faucet, and do not allow any air to enter the mains until the water is again turned on.

MR. J. M. DIVEN: This is a question, gentlemen, that you ought to discuss and we all should have a uniform system. It is often necessary to shut water off for repairs, as we know, and the householder comes to the water works superintendent to know what to do with his hot water boiler, whether it is necessary to let the range fire out entirely. In looking over the rules and regulations of various water departments, find a decided conflict in the instructions given in this regard, and it seems as though some of the members ought to have some experience that would help us out.

MR. P. GEAR: We notify the people that we are going to shut off the water. If the reason for shutting off the water is that there is a broken spindle in a gate, we tell the consumer that according to our previous experience the water may have to be shut off for an hour. Where a gate is broken and the spindle is broken it is hard to shut the gate down because of corrosion. In removing the spindle from some of the gates that were constructed forty years ago, and which we find still in use in our place, we do not find that the gates that are made today are any material improvement over the earlier models. The stuffing box in the older time used to be made of cast iron; the gland was made of cast iron and the top of the gate was cast iron, so that there was nothing to protect the spindle from rust. We found some spindles that we could not take up at all. The bolts that held the stuffing box and the gland together were iron, and the gate was iron, and you had to take that bolt off, perhaps cut it off, and the gland would be rusted sometimes so that you could not turn the spindle. We would tell them that we were going to shut the water off for an hour; but after we took all those things off we would find that the gate was not tight and we would have to keep the water shut off for three hours.

A gate would be free from rust and dirt longer and could be more easily taken apart and cleaned if it was constructed with a brass gland; brass lined stuffing box; top of gate brass lined where the shoulder of the spindle rests; brass bolts and nuts in the stuffing box and slotted for easy removal; the rings in body to be set out one-half inch or more and have a space of one inch on the sides and two inches on the bottom to keep the dirt away from the gate and rings. A gate so made ought to cost but little more than those at present on the market.

MR. W. H. PECK: We notify the people in the territory affected that the water has been shut off. We shut it off for an hour or more if required to complete our work, instructing them to open the hot water faucet and bank their fires. If there is a hot fire on and too much steam generated, if the faucet is left open, it will escape and there will be no danger of exploding their boiler.

In reference to what the last speaker said of gates leaking and passing water, that is a very frequent occurrence, and perhaps the speaker can give some experience which may be valuable although it does not come from one who has been long in the business and who

has found out all of the good methods. When he finds a gate that does not shut tight his practice is to open a fire hydrant in the shut off area and then crack the valve, that is, open it a few turns; the rush of water through the narrow opening carries with it all sediment from the valve seat or recess at the bottom, and the gate will then shut down tight.

MR. P. GEAR: There is not a man in the country who when he goes to shut off a gate will not go back and put his ear down and if he hears the water whistling through he will open it up and shut it down, until it is tight; but after making a certain number of turns they will think they are close to the line where they cannot shut it off any further. If a man finds that he cannot get it tight enough he has to go back to another section. Every man that has anything to do with gates and water works breaks a spindle once in a while when trying to shut a gate down, especially when a big strong husky fellow is told to shut the gate down. He will pull it until he breaks it. If he does not break it in closing it down he will when opening it.

A MEMBER: We have a rule saying that all hot water boilers connected with our service must have check valves as a matter of protection. This puts the responsibility upon the owner of the boiler, and is a good thing.

MR. E. W. HENRY: If the stop-cock on supply pipe to boiler is shut off, and the hot water faucet left open, there is no possible way of the boiler siphoning out.

MR. J. E. BROOKS: The speaker would like to change the wording of that question so that it would cover not what instructions should be given, but does anybody know of any damage that has resulted when water has been shut off?

SECRETARY DIVEN: That question was up last year. You will find it with discussion in last year's proceedings.

MR. JOHN CAULFIELD: We have a rule that requires check valves on every service. We will not turn the water on until those check valves are installed.

MR. E. W. HENRY: A copper boiler will collapse when the water siphons out of it. It costs our city about $30 or $40 to make good such boilers.

MR. P. WALSH: The speaker would like to ask for his own information and in order to get right on the subject as to whether the use of check valves does not make the danger greater when you shut off the main. You are saving the meter, but are you not increasing the danger of explosion?

MR. JOHN CAULFIELD: We require a blow-off or relief valve also.

Question No. 13: Do you use check valves on metered services, if so, why, and what benefit do you derive from them?

MR. H. P. BOHMANN: Only where a system is supplied from two separate lines of pipe. It avoids back registration when one line of pipe is shut off.

MR. WILLIAM LUSCOMBE: The speaker would like to ask those who use check valves at whose expense they are installed, that of the water works or the consumer?

MR. JOHN CAULFIELD: Consumer, in St. Paul.

PRESIDENT THOMAS: How reliable are check valves?

MR. A. A. REIMER: The speaker was a little surprised when Mr. Caulfield said that his enlightened town required check valves and also called for blow-offs on house boilers. You can call for all the blow-offs that you want, but when the blow-off is actually needed the chances are that it has not been used for ten years and that it will not work. That is a case where regulations do not regulate. It would seem that St. Paul has been very fortunate in not having any explosion under those circumstances, due to hot fires. In New Jersey we had a case recently involving a private company, and the speaker was consulted at the time in regard to it. The company had required checks on their services and the house boiler exploded. The woman had kept her fire going pretty strong, so that the generation of steam was sufficient to get beyond the safe limit. There was

considerable damage done and one or two people were injured, so that there was an element of personal injury involved as well as property damage. The testimony showed that all the check valves which were installed by the private company had a very small hole drilled in the check, as the speaker recalls it now a one-sixteenth inch hole. That was done to safe-guard the boilers. In this case the little hole had become stopped up and did not perform its function, with the result mentioned.

The speaker cannot understand why check valves should be required. Regarding the slight damage that could come from hot water backing down into the meter, there again you could put it up to the consumer. There are very few of these cases. The element of danger is one that we should consider, as involving a possible explosion and loss of life.

MR. A. W. CUDDEBACK: The Public Service Commission of New Jersey some little time ago had occasion to rule on the question of check valves. The matter came up on a complaint that was brought by property owners, and in the case of a private water company, they required them to install check valves on the service pipes. The speaker was asked to give his opinion before the Public Utility Commission on the subject as to whether it was a proper and reasonable regulation; and his opinion was that it was not a reasonable regulation. He agrees with Mr. Reimer that the question of putting on check valves is one that can be put up to the consumer, and is not a very important question anyway. The Commission ruled against the check valve.

MR. WILLIAM R. YOUNG: This question involves loss of life. Several years ago in Minneapolis this question came up to us in regard to the necessity of putting a check valve on the sidewalk of a factory. We found a lawsuit was pending, and it looked as though the city was going to be made a party to it as one of the persons responsible for the damage; but after investigation it was found that there was no check valve in, but nevertheless an explosion occurred. The valve was closed by somebody in the plant and the hot water boiler blew up and killed a man. After that the city attorney advised very strongly against the city requiring check valves because he said that thereby the city could be held responsible in case of any damage.

MR. W. H. RANDALL: The speaker differs somewhat with some of the statements in regard to the use of check valves. Suppose, for instance, that a break takes place on a main and you have no time to notify the property owners that you are going to shut the water off. Suppose that a boiler siphons out, which you know happens very often, while your men are at work repairing the main. When the repairs are made you immediately turn on the water and there is just as much danger from the cold water coming back and into the boiler or hot water front as there is if you had a check valve holding the water in. As a matter of fact the consumer has no more right to expect to use the water mains as an expansion tank than we have. That is why we expect them to put a relief valve on their boilers to protect their own premises. Looking at it from a municipal standpoint the property owner must protect his own plant, and the use of check valves is the only safe way. If people are properly educated to it they can thereby protect the buildings or plants in the case of emergencies.

MR. P. GEAR: We find the same trouble with check valves that we do with gates. The speaker has never seen a check valve that would hold water after it had been in a year or two. They may make them that will do so somewhere else, but they do not sell up our way check valves that will hold water. We require a double check valve in all mill services, to protect our mains from the canal water that the manufacturers use in fire pumps, but in small services do not consider them of much benefit.

MR. LOUIS L. TRIBUS: Mr. Ross has some information on this subject, but he is too modest to take the floor himself, so suggest that he be called upon to enlighten us.

MR. WILLIAM ROSS: Check valves were originally put in to prevent the meter registering backward when there was a break in the main and somebody opened a faucet in the house. There are cases where a meter registered backward more than the people had used in a previous year, because it happened to be the meter nearest to the break in the pipe and was registering backward on air. We had a meter in our house that every time the water was turned off on the main would promptly run backward when a faucet was opened. That meter registered backward a great deal more than it did forward.

We were located at a high point on the line and the pressure was off and on several times during the twenty-four hours. It was the only meter in the neighborhood, having been put on by the Superintendent to determine the amount of water used for lawn sprinkling. That meter not only registered backward but it made an interesting racket when doing it. A pressure regulating valve acts much the same as a check valve in case steam is generated on the range boiler and in no case should a steam generator be used without some kind of safety valve attached thereto.

MR. W. D. POLLARD: This question applies more particularly to range boilers. If the hot water faucet is left open when the water is shut off from the main there is little danger to the boiler either by the generation of steam or by the sudden letting in of the water when it is turned on again, provided the water does not remain turned off for a longer period than about ten hours.

MR. E. E. DAVIS: When we shut off the main we notify the property owner to open a hot water faucet. Sometimes we come across a chick-headed negro who doesn't know what a faucet is and the water siphons out when the main is shut off. We had a case where the boiler collapsed and being made of copper it went back to its usual size from the pressure and a little hammering. We had another case of a collapsed boiler, but the head of the boiler instead of being riveted was soldered on, the same as plumbers make a wiped joint. In that case we had to give them a new boiler. Our people are so well educated that just as soon as the pressure goes off they call up the office and ask "What shall we do with our hot water boiler, the water does not run out of the faucet?" We tell them, "Leave the faucet open until it does run."

The speaker has had a good deal of experience with check valves on hot and cold water, and has yet to find a check valve that does not leak. On one large plant we had an eight-inch check valve which was leaking. We took it out and put in two six-inch valves and still the water came back. That was due to bad workmanship. In another case where the meter was running backward the check valve was found to be leaking, just as Mr. Gear said is the case with gate valves. We require two men nearly three months every year fixing valves and placing them in working condition. Some valves at Richmond were put in in 1830 and are in use today; but they require to be looked after.

Question 14: Has any water department or water company ascertained what it costs per consumer to read meter, make out bill, deliver bill and collect bill; that is, total cost of reading meters, making out and collecting bills?

MR. W. S. CRAMER: The speaker has nothing to offer as to the cost of reading meters, making out and collecting bills. Our meters are rather closely located and we read 5600 meters in thirty-six hours by two men last month. It seems as though it does not take any more time to read 5600 meters than 3000.

MR. JOHN CAULFIELD: That beats us. We thought we were rapid.

MR. W. S. CRAMER: From the time we started reading the meters until the bills were ready was seven days. The meters are located on the sidewalk. We have mostly straight reading meters all set at the curb-line, with twenty-four-inch cast iron covers on the meter boxes and eighteen-inch extension dials on the meters. There is a small center cap on the large top. We use a twenty-inch concrete box, thirty inches deep; in the center there is a small cover six inches square, and in reading a smal' stick about eighteen inches long with an iron shoe on the end of it is used to open them. All that is necessary is to raise the center cap so that the readers can see the dial. We never leave the dial tops down, because they are protected by the iron top. In reading it is generally a question of only reading one figure. We use the card system entirely for preserving the reading. These cards are distributed according to routes, and when they are taken out they are thrown in route form in their consecutive number so that a man can carry these cards in his hand, just slipping them one over the other and he can easily refer to the former reading. We never read the odd feet, we just read the nearest hundred; so that it is generally on the ordinary house service necessary only to read one figure.

We are troubled very little with moisture under the glass. Two years ago last February, in the extremely cold weather, we had a little trouble with moisture but we carried an extra man who broke the moisture loose. It possibly reduced the record a little at that time; but very seldom do we have any trouble with moisture.

MR. WILLIAM LUSCOMBE: How many errors in reading do you have in reading that number of meters in that short time?

MR. W. S. CRAMER: Not over ten or twelve. We use a buggy on the outside routes. Our town is laid out in such a way that we have a great many blind streets. One man reads up one side of the streets and the other man the other side, and then they drive back. After they get to the inside route they read on foot all the time, and two men will read 5600 meters in thirty-six hours.

MR. J. M. DIVEN: That is 80 meters per hour, a little better than one a minute.

MR. MORRIS R. SHERRERD: In this meter discussion perhaps it might be well to give you the benefit of a new arrangement that has been worked out by one of our men to be used in case the consumer resorts to the practice of reversing the meter, which we have sometimes found has been done even where the seals were left intact. We put a small change gear on the gear train that will make the dial register forward whether it is set in the line of forward motion or backward motion. When we found that the readings were dropping off and suspected that the consumer might be reversing his meter, we put on one of these reversing gears, without letting him know anything about it, so that he can continue to reverse his meter but it will still read forward.

Question No. 15: What is the average life of a water meter, especially the smaller size—five-eighths to one inch? Has any one any experience in regard to this?

MR. H. P. BOHMANN: Meters used for domestic use last from twenty to twenty-five years. From 150,000 to 200,000 cubic feet registration—should register about 50,000 to 60,000 cubic feet before requiring repairs.

MR. GEORGE HOUSTON: We have had meters in use eighteen years or more, some of them registering as much as 3,000,000 gallons; and with little or no repairs on the gears, after testing them, we found them to be accurate; so consider it is perfectly safe to assume that meters of some makes are good for at least twenty-five years.

MR. A. A. REIMER: In a recent report on certain work in New York City some of the consulting engineers reported the life of meters

at twenty years. Mr. John R. Freeman of Providence, R. I., is using that figure and doubtless others are; whereas perhaps five or ten years ago the reports on valuations of that kind would not show a higher meter life than twelve or fifteen years.

MR. WILLIAM LUSCOMBE: A tabulation of the Wisconsin Public Service Commission places the life of meters at twenty-five years.

MR. C. W. WILES: Does it not depend entirely on the character of the water? Where there is iron in the water no meter will stand up for twenty years according to the speaker's experience. Where the water is filtered you have a different proposition entirely. The meter is affected by the amount of turbidity as well as the amount of iron. Where there is more iron in the water the meter's life will be shorter; and we cannot therefore compare the life of one meter with another.

MR. P. GEAR: The question can be answered in a good many ways. The speaker has a three-fourths-inch meter that he thinks will last forever. It was bought about ten years ago and thought so little of that it is on the bench yet—it was never put in service. We have had some meters in service since 1874. After having registered 28,000,000 to 30,000,000 cubic feet of water, they have been taken out, repaired, and started off with a good prospect of lasting for many years more. Put in a meter where it has a nice gradual run of water, say 25,000 feet a month, and it will last for a long time, but if it runs off 25,000 feet in a couple hours it will use it up pretty fast. Some of the meters that they are making nowadays can be changed around and sent to the factory, repairs made on the interior parts, and the outside will last you forever. We have a meter that was put in use about ten years ago, that has registered 14,000,000 cubic feet of water and it is perfect yet; other meters that were put in about the same time pounded themselves to pieces in four or five years, so that they were only fit for scrap. It all depends upon the class of service that the meter is put on. Repairs to meters are made so gradually that we do not feel the cost; we fix them up as we go along, make new pistons, new discs, or whatever is necessary to renew the working parts, so that we make a new meter out of the old one every four or five years.

Question No. 16: Which is better, to maintain a meter repair department, or send meters to the manufacturers when repairs are needed, especially in the case of small water works?

MR. H. P. BOHMANN: We find it more satisfactory to repair meters in our own shop—too much delay and more costly to send to the factory.

MR. GEORGE A. MAIN: It would seem that the answer to that question depends largely on the location. It is not good practice to send a meter from Florida to the manufacturer for repairs; but in the heart of a manufacturing section near where the meters are made it might be a wise thing to send them to the manufacturer for repair.

MR. WILLIAM R. YOUNG: If one has only a half a dozen meters to be repaired it would hardly pay to run a small repair shop.

MR. C. W. WILES: We always carry in stock some spare gears and discs, and with any little parts of that kind any superintendent can repair a meter if that is all that is needed; but if meters are frozen and the flanges are sprung, the easiest way is to box up a dozen of them and send them to the factory for overhauling. Minor repairs can be attended to generally in your own plant very readily. We manage to repair about 40 per cent of our damaged meters in that way. We have had forty odd repaired at the factory in the last two months. The average cost of repairs taken altogether runs less than $2.50 to $3.50 each, and for the service that the meters have done we can afford to put that money into it.

MR. W. J. WILLS: For minor repairs it would seem that the best thing is to have them attended to in your own repair shop, then ship back to the factory those needing general over-hauling.

MR. W. S. CRAMER: Any man capable of reading and inspecting meters should be able to make all ordinary repairs to meters, but would not advise the installation of machinery or the employment of skilled labor other than that necessary to care for meters in operation. We have nothing except a drill press and a good bench outfit, with all necessary taps and dies and in ten years we have found it necessary to send but six meters to the factory for repairs and of this number two had been frozen.

All our meters are tested on receipt from factory and all meters are tested whenever taken out if they are in but a month or less.

We find that the time of our meter readers is nicely divided between reading, repairing and testing, and with time left in which to do daily reading of large meters and weekly reading of commercial meters, and inspections.

MR. GEORGE HOUSTON: It is quite interesting to note the difference of opinion on this subject among good, honest, intelligent people in different parts of the country. We have in the neighborhood of 7000 meters. Two men do all the repairing, taking out the meters, cleaning, testing and again replacing them in position. One of these men gets a salary of $100 a month, the other $70 a month. Three years ago this last winter we had in the neighborhood of 450 meters frozen, some of them of course being badly damaged. Two years ago we had in the neighborhood of 300; last winter we had 350 or upward. Of those frozen meters we sent back 3 to the factory; and of all the disc chambers that were damaged there were but 21 that we had to send back to the factory for repairs. Now we test and put back on an average about 150 meters a month at the cost equal to the salaries of these two men who do all the repairing and cleaning, and also all shutting off and turning on of water, and look after delinquent collections. Any man who is any kind of a mechanic at all can in a short time repair almost any meter and put it in working order.

Inasmuch as we have an accurate testing machine we know what our meters are doing. We never test a meter for accuracy on less than a one-sixteenth-inch stream; usually we use a three-eighths-inch stream. Have not taken the pains to figure up what our saving has been, from what it would have cost us had we sent all these meters back to the factory. You can make the calculation for yourself. There are freight charges and cartage, and sometimes if you send a meter away the cost of express charges both ways will exceed the cost of material and time in making repairs. Besides, at this season of the year (the winter season) the factories are crowded with meters returned from other sections, and you will probably not get your meter back for two or three months. That necessitates putting in another meter making more office work which all adds to the expense of running the department.

Question No. 17: What is the responsibility of a water company or department for damages caused by bursting water mains?

MR. H. P. BOHMANN: Where no negligence can be proven the city is not liable as held by our City Attorney and sustained by the court.

MR. WILLIAM R. YOUNG: A short time ago in Lake City, Minnesota, a question came up as to the damage, and our local attorneys of Minneapolis decided for us on a question where water mains were on streets that had been vacated, that the main should be removed, or otherwise the city would be held for any damages that might occur on account of the break of such mains.

On the strength of our attorney's recommendation and the cases cited, the water mains were all ordered cut off under those buildings at quite an expense to the manufacturers, and new mains are now being constructed.

MR. W. H. RANDALL: Did we understand the last speaker to say that the mains were laid under the building?

MR. WILLIAM R. YOUNG: No, the streets were vacated after the mains had been laid, and the main alluded to remained there. The streets were vacated and turned into railroad property.

MR. W. H. RANDALL: We have had in Toronto two very serious breaks during the last winter in a thirty-six-inch main. Our Solicitor in Toronto was asked as to the liability of the city, the mains being laid on city property and on a city street. Two thirty-six-inch mains broke inside of probably three weeks' time. One split the whole length of the pipe; in the other the whole side of the pipe was practically blown out. Our Solicitor when interviewed by the gentlemen of the press, stated to them that the city had no responsibility, that it was an act of Providence, something that could not have been foreseen, and the city did not accept any liability as far as it was concerned.

MR. JOHN M. DIVEN: It is the law of the State of New York that property damaged must show negligence on the part of the water department to make them liable.

Question No. 18: It is a well known fact that when a thaw begins, and the frost goes out at the surface of the ground, there is increased trouble from frozen underground pipes; can any one explain or give the cause of this trouble?

MR. MORRIS R. SHERRERD: The cause of the apparent increase in the depth to which the frost goes in time of thaw is what in physics is called "The latent heat of fusion." Heat is taken up from the water pipe and ground, when the thaw takes place. This gives the effect of sending the frost deeper for the time of thaw.

MR. P. GEAR: We have had experience with frozen pipes on fine warm days which followed a period of cold nights and days and attribute it to the fact that people who have no meter on their services, allow their water to run during the cold weather so it will not freeze. When the warm day comes they shut their faucets off and the result is a frozen pipe. If you take a piece of iron, heat one end of it and put the heated end in cold water, the heat will be driven back to the end you hold in your hand. In the same manner probably the heat developed on a warm day drives the frost down enough to cause a freeze.

PRESIDENT THOMAS: On the question of whether there is any set charge for fire service, Mr. Blauvelt might know whether there is any fixed practice in that regard or not. Down our way we do not make a charge for such service. What do you say, Mr. Blauvelt?

MR. ALBERT BLAUVELT: Usually privately owned water works charge for fire service. Publicly owned do not, although it is strange that they do not, because it is a service that costs money and some one has to pay for it.

PRESIDENT THOMAS: But there are very few publicly owned water works that have a specific charge at a fixed rate.

MR. ALBERT BLAUVELT: Yes, sir, but it is a good and valuable service or the property owner would not want it. It saves him investment in something else that would take its place. Mr. Metcalf has been making a study as to the propriety of the charge.

PENALTIES FOR NON-PAYMENT OF WATER BILLS

MR. GEORGE A. MAIN: We have had the question of penalties for non-payment of water bills up for some little time, and would like to get any information as to court decisions regarding penalties for non-payment at prescribed times. We are charging 50 cents penalty if the bill is not paid by the tenth of the following month, and it is claimed by some that this is usury. Has any member had any experience or decision that can be used to assure the Board of Public Works of Daytona that we are doing right? We do not like the idea of shutting the water off without sending a second statement. Our plan has been if the bill is not paid on the tenth, to send a second statement on the eleventh which will include 50 cents additional; and if not paid on the thirtieth, the water is turned off. If this question has ever been thrashed out in the courts we would appreciate some information concerning it.

PRESIDENT THOMAS: Can anybody here give any information regarding that matter, or does any one know whether there are any legal decisions as to the propriety of exacting a penalty for failing to pay water bills on time?

MR. LOUIS L. TRIBUS: New York City provides that its water rents in default are to be collected with taxes in arrears, and it exacts 7 per cent per annum as interest on defaulted payments beyond a certain date, and if not paid within a further specified period, it proceeds to sell the property. It becomes a lien on the property the same as other taxes; so it would seem that it is in the nature of a penalty that becomes enforcible by sale. The case referred to by the last speaker may be local.

MR. GEORGE A. MAIN: In some cases the amount exceeded the legal rate of interest, while the last speaker says they allow 7 per cent. That is 1 per cent more than their legal rate.

MR. R. F. JOHNSON: In our state we charge 5 per cent penalty after the tenth of the second month; for example, quarter from April 1 to July 1, if not paid on the tenth of May we charge 5 per cent penalty which becomes a lien on the property, and every once in a while when property is sold with back water rent due we notify the purchaser that there is a cloud on his title. We have no difficulty in collecting 5 per cent, with, however, a provision that there shall be no charge on this account less than 10 cents.

METERING WATER USED FOR CONSTRUCTION

MR. OSCAR BULKELEY: What is the general practice in regard to metering water used for construction purposes, such as paving streets and sewer back filling; whether meters are used; whether it is advisable to use them, and what is the maximum size preferable to use? We are thinking of limiting the size to one inch, because of the danger involved in the use of larger meters on fire hydrants. We have had a great deal of trouble from the misuse of metered fire hydrants.

MR. JOHN M. DIVEN: The ordinary demand is for three-fourths-inch connection with five-eighths-inch meter. Three-fourths-inch hose is ordinarily used for such work.

MR. OSCAR BULKELEY: The contractors are very anxious to have two or three-inch meters for filling tanks.

MR. JOHN M. DIVEN: One great difficulty in the use of meters for this kind of service is the danger of their being tampered with, as they are necessarily set in exposed places; to put them in substantial pits would be too expensive for temporary service.

MR. A. A REIMER: Our practice has been to absolutely taboo the use of meters on that class of work. So far as the street work is concerned, where the meter might be placed on the hydrant we condemn it, because we place the hydrants there for one purpose and one only, namely, that of fire-fighting; and if you have a meter with the necessary fittings attached to the hydrant and a fire call comes in making it necessary to use that particular hydrant, you are up against it, and there is nothing but condemnation handed out to you for having the meter there and preventing the use of the hydrant.

When it comes to the use of meters on buildings in course of construction, that is a different question, but at the same time you are always running the risk of having the meter damaged by falling material, iron, wooden beams, etc.; and therefore the contractor should be required to put a strong construction around the meter to protect it. We have preferred to use the flat rate for all such demands until after the building is completed, then we set the meter and know that we are safe.

MR. OSCAR BULKELEY: That is what we were planning to do, to eliminate meter rates on construction work of that kind, particularly in the erection of houses; but how do you supply water to contractors on streets for back filling of trenches and pavement work?

MR. A. A. REIMER: We control all that work ourselves. We have a gang that we utilize for that class of work who know how to handle the hydrants, instead of putting them into the hands of men who do not know how to use them and who might put them out of business. We have a flushing gang that tend to that class of work, and we charge for the service. If the contractor is in a part of the city where he cannot get water except from the hydrants we use a Heim valve on the hydrant.

HOUSE TO HOUSE INSPECTIONS

By A. Prescott Folwell

Among the subjects suggested for discussion at the experience meeting of this convention was that of house to house inspections, how often they should be made, and whether they should be continuous by a small regular force, or whether general periodic inspections should be made. As a contribution to this discussion, the writer is able to give some information as to present practices in more than 350 plants, of which 276 are municipal plants and the balance private plants. This information he obtained within the past month by direct correspondence with these cities, in connection with other data which he was obtaining.

Taking first the 276 municipal plants, we find 38 of these reporting that inspectors are kept continuously at work making these house to house inspections; 228 report periodic inspections, and 10 report that no inspections are made.

In a great many cases no information further than this was given, but a number of the superintendents gave particulars concerning the carrying on of this work. One Massachusetts city reported using six inspectors continuously for reading meters and inspecting house plumbing, while another smaller place kept one man at this work. St. Louis reports 35 men continuously inspecting house plumbing; Canton, Ohio, two regular men with an extra man occasionally, and Harrisburg, Pennsylvania, two inspectors continuously.

Of the periodic inspections, the interval was stated to be once a month in the case of Key West, Florida; Salem, Illinois; Cherryvale, Kansas; Cambridge, Clinton and Taunton, Massachusetts; Cloquet and Duluth, Minnesota; Fairbury, Nebraska; Grand Forks, North Dakota; Davis, Oklahoma; Bay City, Texas; Charlottesville, Virginia, and Bellingham, Washington; a total of 14 cities.

Quarterly inspections are reported by Fort Dodge, Iowa; Belmont, Massachusetts; Pipestone and St. Peter, Minnesota; Farmington, Missouri; University Place, Nebraska; Dover, New Jersey; Peekskill, and Watkins, New York; East Cleveland, Medina and Read-

ing, Ohio; East Providence, Rhode Island; Huron, South Dakota; Pullman, Washington; Sistersville, West Virginia; Fort Atkinson and Marshfield, Wisconsin; a total of 18.

Inspections twice a year are reported by Waterbury, Connecticut; Marquoketa, Iowa; Winfield, Kansas; Winthrop, Massachusetts; Lestershire and Whitehall, New York; Brownwood, Texas, and Fairmont, West Virginia; a total of 8.

Annual inspections are made by Whittier, California; Greeley and Silverton, Colorado; St. Petersburg, Florida; Blue Island, Illinois; Chestertown, Maryland; Andover, Natick, and New Bedford, Massachusetts; Fulton, Missouri; Keene, New Hampshire; Cape May, New Jersey; Hoosick Falls and Newark, New York; Medford, Oregon; Brookville and McKeesport, Pennsylvania, and Ephraim, Utah; a total of 18.

Among other intervals named are once in two years by Boyne City, Michigan; Auburn and Salamanca, New York; Bradford and Shippensburg, Pennsylvania.

Providence, Rhode Island, makes an inspection every three years, when the annual rates are changed.

Practically all of those which report no inspection give as a reason that this is not necessary because the services are metered, while a number of others report that metered properties are not inspected, but only those on flat rates. Still others report that the periodic inspections are made by the meter reader when reading the meter, and there may be question as to whether this means an inspection of the entire premises or only of the meter and its connections.

The above shows that at least 64 of the 228 which have periodic inspections make these at stated intervals; and it is extremely probable that a considerable proportion of the others also have a regular schedule for this work. A number of the cities, however, report that such inspections are made "occasionally," "on request," "infrequently," etc.

Of the 77 private plants, 10 report continuous inspection by a permanently employed force, while 67 report periodic inspections. Monthly inspections are reported by 3 superintendents, quarterly inspections by 1, annual inspections by 7, biennial by 2, and once in five years by 1. Six report inspection "occasionally," 1 "frequently," and 1 "when complaint is made."

It might be of interest and possibly of some significance to state that these figures are taken from something over 500 reports made

by water works superintendents to a set of questions which had been submitted to them, and that a little over 30 per cent made no reply to the question at all. It would probably be fair to infer that a considerable percentage of these did not make any inspections, either continuously or periodically. If we assume this to be true of half of those who failed to report, we have about 45 cities out of 525, or between 8 and 9 per cent, which make no inspections, a smaller percentage than the writer would have supposed in the absence of any data.

LEGAL DECISION IN A WATER SUPPLY POLLUTION CASE

By J. Walter Ackerman

It was the privilege of the writer last year to read a short paper before the American Water Works Association on a case in court, concerning water pollution.[1] The major points which were given to you were along the lines of what the writer had developed by means of experimental data as to what the effect of the wind was upon the surface currents of a lake.

The main facts of the case were these: The City of Auburn, New York, with a population of about 36,000, takes its water supply from one of the finger lakes of central New York known as Owasco Lake, the drainage area of the same being about 200 square miles, and total length of the lake, 10 miles. The supply drawn for the city comes from the outlet end, and the inlet stream, comprising something like 60 per cent of the total drainage area, enters the lake about 10 miles from the intake crib.

Four miles from the head of the lake is situated the village of Moravia. The Board of Education of that village caused to be constructed a sewer, which led from the High School building to the bank of Mill Creek, one of the tributaries to the inlet stream. This sewer carried the excreta from about three hundred students who attended the school.

The public health law of the State of New York provides that a municipality or corporation furnishing water for domestic supply purposes can secure from the State a promulgation of certain rules and regulations which give to the municipality or corporation furnishing the supply certain police, or restrictive powers, which are supposed to give the water company an opportunity of protecting their water supply.

Section 73 of the general public health law of the State of New York, however, provides, in general, that, when a water company desires certain pollution to be removed from the watershed, the

[1] Water Movement Compared with Air Movement and its Relation to Lake Contamination. *Proceedings*, 1913, pp. 291, etc.

water company must reimburse the property owner for any damage done, and the attorney general has rendered the following opinion:

> In my opinion the proper and only lawful construction which can be placed on Section 73 of the Public Health Law is that all damages and injury to the owner of any property affected by changes required to be made to comply with the rules of the Department of Health must be ascertained and paid prior to the taking possession of the property, and is a prerequisite to the enforcement of said rules in all cases except such as are a nuisance in and of themselves, in which cases the Department of Health would have power and authority outside of Sections 70, 71 and 73 to abate the same.

As the pollution at this High School was one of the most gross, and also the most impersonal one, the water board decided to try it out on its merits. Obviously, from the above, the problem could not be attacked by means of the public health law, as that might necessitate our immediate payment to the parties damaged. And it appeared to the Auburn water department that there was a distinct difference between pollution of this nature and some other acts which constitute a pollution under the rules governing the watershed. That is, the farmer who happened to own land through which passed a stream tributary to our lake, had certain riparian rights which were different from those of the High School. That is, he had purchased his land for the sole and only purpose of carrying on the business of agriculture. Hence, he was entitled to the use of the same, to be used in the usual way of pasturing his cattle, manuring his fields, and any other acts of husbandry which are normally carried on upon a property devoted to farming. And while these ordinary acts might constitute a violation of the rules of our department, and might also cause pollution, if not even infection, of our water supply, the High School was distinctly different. It was not situated originally on a stream, and therefore it lacked the riparian rights which the farmer had, and it created an artificial channel and carried to Mill Creek the excreta from the students attending the same, which if left at the point of the High School, might not, even with the rainfall and washing, have carried the polluting material to Owasco Lake. But owing to the fact that the Board of Education caused to be constructed this sewer, which conveyed the material from a place where no riparian rights whatever existed, to the bank or bed of the stream, this appeared to the Board and its attorneys to be an entirely different situation, and consequently the general ruling of the attorney general did not seem

to fit this particular case. But in order to avoid any complication with the state health law, the problem was attacked under the head of the Penal Code, under sections 1530 and 1532, which are as follows:

Section 1530. Public Nuisance Defined.

A "public nuisance" is a crime against the order and economy of the state, and consists in unlawfully doing an act, or omitting to perform a duty, which act or omission:

1. Annoys, injures or endangers the comfort, repose, health or safety of any considerable number of persons; or,

2. Offends public decency; or,

4. In any way renders a considerable number of persons insecure in life, or the use of property.

Subdivision 3 does not in any way apply in this case, so it is omitted.

Section 1532. Maintaining Nuisance.

A person who commits or maintains a public nuisance, the punishment for which is not specially prescribed, or who wilfully omits or refuses to perform any legal duty relating to the removal of such a public nuisance, is guilty of a misdemeanor.

The defendant was indicted by the January, 1911, grand jury, for the crime of maintaining a public nuisance. This indictment contained three counts, and stripped of its legal verbiage, the first count is based upon an alleged offense against public decency, which is the second subdivision of the definition of a public nuisance.

The second count rests on the first subdivision of the definition, which charges a wilful act or omission to perform a duty that annoys, injures or endangers the comfort, repose, health or safety of any considerable number of persons. And in this second count there are two things mentioned and complained about: The alleged pollution at the mouth of the sewer, causing poisonous and deleterious odors, and so on; and second, the pollution of the water of Owasco Lake.

So far as the deposit at the mouth of the sewer is concerned, with regard to the smells and odors, the persons harmed by these obviously would be only those who live in the immediate vicinity. The class who are harmed by the pollution of the water, if any, would be those who use Owasco Lake as a source of water supply, like the cottagers along the lake, and of course, more especially the people of Auburn who depend upon Owasco Lake as their source of drinking water.

The third count of the indictment is based upon the fourth subdivision of the definition of a public nuisance, in that it is charged that the conditions render a considerable number of persons insecure in life or the use of property.

After a number of delays, the case was first brought in supreme court, before Mr. Justice William W. Clark, in April, 1913. This was a mistrial, as the jury disagreed. The usual twelfth juror failed to make the other eleven believe in acquittal.

Preparations were again made and the case was brought to trial a second time on March 20 of this year, before the Honorable Arthur E. Sutherland, justice of the supreme court.

On the original trial Professors Mason, Whipple and Winslow were the experts for the people. And they also rendered the same service in the second trial. The people were further aided in the second trial by the addition to this star representation, of Nicholas S. Hill, Jr.

With such experimental data as had been collected by the writer as to time of flow of the stream from Moravia village to the lake, and the surface currents in the lake under influence of wind action, the experts dwelt upon the general principles of the transmission of communicable diseases the prevalence of typhoid fever among the High School students at Moravia and the possibility of typhoid fever carriers, the number of typhoid fever bacilli in fecal matter and in urine, other diseases transmitted through fecal matter, dysentery, children's diseases, etc., life of typhoid fever bacilli in water, and examples of waterborne typhoid fever in other places.

This completed the chain of evidence as to the possibilities of typhoid fever germs to travel from the outlet of the sewer down the inlet and across the lake, a distance of 14 miles, well within the vigorous lifetime of typhoid fever bacilli.

The result of this trial was a verdict of not guilty on the first two counts, and guilty on the third count. This verdict was rendered evidently for the reason that the jury did not care to find that the condition at the opening of the sewer annoyed and injured the comfort and repose of Moravia citizens, because the preponderance of evidence by the people of Moravia showed that no one had ever smelled an odor, and that the sight of the excreta as remaining on the banks of the stream, had not in any way endangered their comfort or repose. In fact, the judge, in discussing informally the points of the indictment with the attorneys in the case, remarked that to the people living in Moravia this appeared to be a geranium bed.

Now, a word as to the code under which this indictment was found:

This is a common law crime, and while the Penal Code, in this exact form, exists in New York State only, the laws of any of the States, with the possible exception of Louisiana, are based upon the same common source, that is, the common law of England. Consequently, there is some law in each and every one of the States of the Union, with the possible exception of Louisiana, that is practically like the one quoted here. In fact, the district attorney in summing up the case, dwelt particularly upon the fact that this is one of the oldest laws known, and might be traced back through generations to England and its common law, and even back to the time of Moses. He also quoted from Deuteronomy 23, 12 and 13, which is as follows:

> Thou shalt have a place also without the camp, whither thou shalt go forth abroad:
>
> And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee.

DISCUSSION

Mr. Nicholas S. Hill, Jr.: In many respects the case which Mr. Ackerman has just outlined is one of the most interesting with which the speaker has ever had the good fortune to be connected; not alone because it presented a new method of obtaining relief from pollution of a public water supply, one that the speaker does not know of as having been tried heretofore, but chiefly because the case was so beautifully prepared and put together by the very able attorneys for the city, with the assistance chiefly of Professor Winslow and Doctor Mason. It may be said that in October, November and December of 1907 quite a number of typhoid fever cases were noted in Moravia. The plaintiff, the city of Auburn, brought witnesses to show that certain of these typhoid patients had returned to the high school in February, 1908. These patients of course were presumably carriers, because it is a well-known fact that convalescents from typhoid are usually carriers for a considerable period of time.

Following March 1, 1908, there was a decided thaw, which was traced by the records of rising temperature, and also by the records

maintained by the Auburn Water Department, which showed a rise in the discharge from Owasco Lake. The bacteriological records at the water works in Auburn also showed a sharp and decided rise in the bacterial count; but about this time, or immediately following this thaw, through the experiments carried on by Mr. Ackerman, and which were published in last year's proceedings of the American Water Works Association, there had been established a relation between the wind velocities, wind coefficients or components composing the wind and water movements. The result was that having the records of the United States Weather Bureau giving the velocity and the direction of the wind, we were able to compute with a reasonable degree of accuracy that the wind movements between about the 20th and 26th of March were sufficient to carry the water down Owasco Lake for a distance of sixteen miles, in the time required for pollution to pass from Moravia to the intake. As the lake was only ten miles long there was ample margin for error in the assumptions which have been made. It was also shown that it required only a few days for the sewage to pass from Moravia to the lake. Fifteen days following April 1st there was a marked rise in the typhoid fever rate in the city of Auburn. So the whole case pieces together in a remarkably satisfactory way, a way in which one is seldom able to piece evidence of this kind together; and it was largely because of the coincidence of all these elements in the case that the verdict was obtained.

MR. J. WALTER ACKERMAN: The author's principal reason for giving this short history was that the action was brought under the Penal Code under the head of Nuisances, as that represented an entire departure from the method heretofore followed in seeking and applying remedy for this sort of pollution. While we know not what the future of the case will be, we stand ready and prepared to carry it up as far as they desire it to be carried; so that if the municipality does carry the case up, we will follow it.

AN UNDEVELOPED FIELD IN WATER WORKS MANAGEMENT

By Paul Hansen

Those who have had an opportunity to visit large numbers of small water works, as well as a variety of other small public utilities, more particularly in the smaller communities, cannot fail to be impressed with the generally unsystematic, unscientific and slipshod methods of operation. Among several hundred small water works, i.e., in cities under 25,000 population, with which the writer has acquaintance, there are but a very few where good operating records and financial accounts are maintained, and where a commendable technical skill is shown. The writer is obliged to say that these exceptions are very nearly all among the privately owned plants, though he is far from being committed to any definite stand on private versus municipal ownership.

The result of poor management is generally poor service, or good service purchased at cost much too high. The fault is not always, or even generally, that of the man in charge, because it is ordinarily not possible to obtain a man for the salaries offered, or even for the salaries that might reasonably be paid, who is a thorough water works expert; nor is it possible, in connection with the more complex water works installations, to find in one man the diverse knowledge necessary to secure the most effective and economical service in all departments. The most logical, the simplest, and the most readily available method of overcoming these difficulties is that of retaining the services of competent consulting engineers, on an annual basis, to supervise operation. As such work, once it is well initiated, can be carried on with but a small expenditure of time, it may be rendered at small expense, probably not exceeding $600 per annum. This procedure is not new or novel, but is seldom resorted to, whereas it should constitute a general custom. Large works do not need it, generally speaking, because such works are supervised by full time employes, who are specialists in various lines of water works design and operation; yet it is significant that, when

difficult problems arise in connection with large water works, the management is quick to avail itself of outside expert services.

Three factors enter into the supervision which a consulting expert exercises, viz:

1. Operating records;
2. Financial accounts;
3. Technical skill.

Operating records relate to physical facts such as yield and quality of source of supply, performance of pumping stations, and the condition of the distribution system and reservoirs.

Financial records should permit of readily making a complete analysis of costs of operation and maintenance, and, to this end, should include fully itemized capital, maintenance, repair, replacement, sinking fund, depreciation and interest accounts. Unit costs should also be prepared on all material purchased and work done.

Technical skill should be possessed in a preëminent degree by the consulting engineer, that he may instruct those in direct charge in the proper manipulation of the water works equipment, and that he may correctly interpret the significance of the records that are maintained under his direction.

A plan such as outlined will not only improve operation, but will also improve water works design, for it will give consulting engineers an opportunity to ascertain how their own designs "work out," an opportunity strangely lacking at the present time. Design and operation must go hand in hand, for the engineer cannot be proficient in the one without being proficient in the other. If once this system is fairly tried, it is difficult to believe that it will not grow in favor.

DISCUSSION

THE INDIVIDUALITY OF PUBLIC UTILITIES, NOTABLY WATER WORKS

By W. E. Miller

Printed in Journal of the American Water Works Association, Vol. 1, No. 3, September, 1914, at page 614, and presented at the Philadelphia Convention, May, 1914.

Mr. A. A. Reimer: Referring to the figures given by Mr. Miller as the average cost of water systems per capita and per million gallons pumped, the speaker came in contact with some of the engineers of the National Board of Fire Underwriters during a recent survey by that board, and, in discussing the water system of the company under survey, these engineers told the speaker that they considered that to be up to date a system of fire protection seldom cost less than $40 per capita. This is given as an interesting fact and to show the attitude of the National Board of Fire Underwriters.

In more recent years we have had an engineer who is a specialist working on our system, and today we consider it to be in first class condition.

DISCUSSION

EQUITABLE HYDRANT RENTALS AND BETTER METHODS FOR APPORTIONING FIRE PROTECTION COST

By Mr. John W. Alvord

Printed in Journal of the American Water Works Association, Vol. 1, No. 1, March, 1914, at page 95, and presented for discussion at the Philadelphia Convention of the Association, May, 1914.

For other discussion on this paper see Vol. 1, No. 3, September, 1914, Journal American Water Works Association, pp. 538–545.

Mr. J. Davis Barnet: Mr. Alvord's paper is well in keeping with what has always appeared to the speaker the most interesting paper that was ever read before us, that of two years ago on "hydrant rental." But it seems to him that Mr. Alvord's formula would be more equitable had he used the area instead of the diameter and a lower figure for his constant. In working his figures out for a plant covering but 15,000 people it is evident that for a plant as small as that you would have to come up from one-half cent to five-eighths cent, if not three-fourths of a cent. The speaker does not wish to criticise Mr. Alvord, because he thinks he was justified in putting this simply before us and thus getting his formula into the shortest form in which it could be put; but from the slight analysis the speaker has made he thinks that squaring the diameter, using a lower constant (in the decimal point) and getting a higher figure in the answer would be necessary for most of us.

Mr. Oscar Bulkeley: Mr. Alvord, the author of this paper, makes the statement (see page 96) "The proper method of dividing the cost of public and private services is (1) to make a valuation of the plant; (2) to make a study of the value of a theoretical plant, sufficient in capacity for fire service only; and (3) a study of the

value of a theoretical plant, capable of domestic service only." Is this theoretical plant whose value is estimated to be one which will furnish the same measure or degree of fire protection as found in the existing plant under consideration? The actual plant may be, and quite often is, sadly inadequate for even reasonable fire protection. In such a case, probably, the author of the paper would improve the actual plant, in the case of a municipally owned water works, by means of a bond issue. In view of the exceeding reluctance on the part of many cities to issue bonds for any purpose, and the consequent necessity of depending upon the annual revenue to furnish the funds for making permanent improvements, the speaker has wondered if for purposes of rate making the theoretical plant might not in equity be one which would adequately serve the community and thus secure a greater income with which the plant can be gradually improved and the distribution system properly reinforced. The speaker being a young engineer, hesitates to comment upon a paper presented by Mr. Alvord, but does so because the question of how to build up a water works plant is so vital and so real.

MR. H. C. HODGKINS: The speaker would like to state an interesting fact which perhaps has escaped the attention of some of you. The first water plant that he was interested in was in the State of New York. Under the laws of the State at that time, its distribution pipes were classed as personal property, and the indebtedness was an offset against all the personal property. The assessment was somewhere between $50,000 and $60,000, but allowing for this offset under the statute, the result was that the taxes on the plant were $200. You can readily see that the returns to which the company would be entitled in the shape of rates would be somewhat different than if they had been paying taxes on all their property as real estate. At that time the Western Union Telegraph lines were the only property, over or through highways, that were considered real estate, and they were so classed by a special statute.

MR. A. A. REIMER: The speaker does not care to discuss Mr. Alvord's paper, but cannot, nevertheless, willingly pass by an opportunity to put in a word for the municipal plant which is getting nothing for its hydrants. He feels that those of us who are interested in municipal plants should take every opportunity we can to push along the idea of receiving a fair return for service rendered. We are placed

in an unfair position every time we are compared with a private concern that is in good hands. The feeling of this Association, both of those representing private interests and those representing municipal plants, should be to help along any movement that helps either of these interests.

Now some few plants in the country are receiving a fair return, or a partial return for the services rendered, in this line; but before you can compare one system with another you must know that the conditions are the same in order to get a fair comparison. In order to find out what we are putting into our "Charity Fund" as we facetiously label it at home, the speaker made the calculation which was referred to in Mr. Alvord's paper of designing a system to furnish fire protection. He did this some three or four years ago, and found that it would cost us about $26 for every hydrant that we had in service in the city. That figure is somewhat lessened now by the increase in the number of hydrants, but we will soon be obliged to have a larger system in order to get that additional fire protection which must of necessity come in a comparatively short time.

MR. ALBERT BLAUVELT: Mr. Alvord refers to a municipal water works with cost of operation estimated separately as if solely for private fire service and the same estimated as if solely for public service. It would be interesting to know what would result by combining the two estimates that he mentions and after such combination make two additional estimates. One estimate to show cost of operation of the water works with pressure service on, all hands on duty, coal coming off of the coal pile but with no water being used or drawn, that is to say, the pumps would be moving only because of leakage and slippage. The second estimate to be the same but with any addition needed to account for normal use or consumption of water. The speaker begs to ask Mr. Alvord whether he has any such figures.

MR. JOHN W. ALVORD: That is precisely the problem which you have to solve. You must estimate the cost of two different plants in order to get the ratio between fire and domestic service. You have a plant before you to be valued, and you first of all assume that that plant is built to furnish fire protection only, in which case it is there ready to serve but not operating 99 per cent of the time, the engines are warmed up, the pumps turned over once in a while,

and everything in readiness for a fire; under these conditions you calculate your operating expenses, and you calculate the cost of the pipe system and the pumps on a fire service basis; then you make a comparison of this strictly fire service plant with a strictly domestic service plant in which you do not have to furnish fire service, but do furnish water for domestic consumption only, and that gives you the ratio which you can apply to the two combined services of the plant under consideration, with its known value. Does this make it clear?

MR. ALBERT BLAUVELT: Yes, the meaning is clear; however, it may be useful to develop the thought the speaker has endeavored to suggest. One of the difficulties that you gentlemen have is that the public is more or less under the impression that if and when water is not being used it does not then cost the water works anything for domestic service or for fire protection. If it can be shown to the public that it costs a water works as much or more for "stand by service" as for "flow service" it may thereby be possible to show the public that the "stand by service" must invariably be reckoned for payment. In arguments for charges for water for fire department use the speaker believes that material aid can be gained by developing the truth of the cost of the "stand by service" as an offset to the people who claim that fire protection service costs nothing at such times as water is not being used.

MR. W. C. HAWLEY: There is an interesting point that the speaker overlooked, and that is the effect on the quality of fire protection provided in the municipalities that have now come under the new scheme. The first municipality that we made a contract with at once increased its hydrants from 34 to 50. The second at once increased from 31 to 50; so it has been with all those that have made new contracts. The last one has ordered 150 more hydrants, whereas at present it has 137. That means a great improvement in the quality of the fire protection, because of the added number of hydrants which would not have been set before because every hydrant meant so many dollars a year.

MR. JOHN W. ALVORD: Perhaps the author may be able to throw some light on some of the suggestions that have been made. Mr. Chester has made a direct application of some figures given as a

tentative conclusion in the illustration in the paper to a number of his own plants with which he is familiar and which probably have quite different conditions; but it must be remembered that this is not a mathematical demonstration or a final conclusion expressed in figures; it is a description of a fundamental principle; and all that has been attempted in the paper is to illustrate that fundamental principle with one example which has been actually worked out. Undoubtedly the principle properly applied will work out very differently as to its mathematical results, when applied to any other set of conditions on another plant. The author doubts if anybody in this Association has more frequently reiterated that we ought not to apply figures applicable to one plant indiscriminately to another plant than has my good friend Mr. Chester.

Mr. Barnet of course correctly raises a theoretically valid objection that the ratio is not perfect; and that must be admitted promptly. The paper states:

> It is true that the cost and capacity of mains increase at a rate greater than the first power of the diameter. The capacity increases as the square of the diameter, and the cost between the first power and the square. If the cost of the mains is increased by replacement and cost of cutting through pavements, the adjustment of cost as between different diameters will be closer.

But it is desirable in all these determinations and in all these methods to get simplicity. It might be desirable, under some conditions (and there is no objection to it if anybody wants to do it), to introduce a rule that would be mathematically exact and thus more accurate than the one suggested; but it would not be so simple. If we can accomplish anything by increased mathematical exactness, well and good; but practically the rule suggested is the simpler way and will not lead to any incorrect results.

Mr. Hawley mentioned a difficulty that might arise as between three contiguous cities, using the same feeder main from a reservoir. The author does not apprehend that there would be any difficulty in adjusting rates under those conditions especially if we could adjust rates in all of the three cities at the same time, because we can certainly apportion the capacity of the main to the three cities individually, either in proportion to their consumption, or population, or any other way that would seem fair; and then rate them in accordance with that division. The main advantage of the method proposed is that it permits a city having an adequate pipe distribution

system to pay fire protection rental in proportion. It eliminates that uncomfortable problem which arises through extending distribution pipes out into the outskirts of a city by reason of the fact that ordinary hydrant rentals are a flat rate and therefore inordinately high on the outskirts of a town, in proportion to the service. That is the great cause of criticism of the incongruous flat hydrant rate.

MR. OSCAR BULKELEY: Mr. Alvord did not say whether that theoretical plant was supposed to equal in measure of efficiency the existing plant that he was attempting to compare with it.

MR. JOHN W. ALVORD: On the one hand you are hypothetically remodeling your plant to serve your domestic consumption, which of course means that you do not have to have such large distribution pipes and not quite so much pump capacity, nor so much water available for sudden emergencies as you need to have for fire protection, but in every other way keeping close to the model plant before you that you are fixing rates for. Then you turn around and hypothetically remodel it for a strictly fire protection proposition, which of course means keeping your pipe system exactly as good as it should be under present conditions and providing sufficient pumping power. Then you go through the same hypothetical examination with the operating expense, which as Mr. Blauvelt has pointed out is, in the case of a fire protection system, a stand-by proposition, on the one hand, and on the other hand a constant pumping proposition for domestic consumption alone. These two results, correctly worked out, give you the ratios which you can use to divide the real operating cost correctly; that is to say, the costs on your actual plant as between fire protection and domestic consumption. Now the point that you raise, it seems to the author, has more to do with the question of financing extensions. It seems to him that is rather outside of the question before us. Of course that is always a problem in every city, to raise the proper proportion of moneys for public use and fire protection; but the point raised here is that most of our cities are not paying what they ought to pay for the fire protection service when the matter is carefully examined.

MR. OSCAR BULKELEY: That was the point that rose in the speaker's mind, the fact that the existing plant may be inadequate.

Now if the existing plant is inadequate by $200,000 or $300,000 of needed reinforcement to the distribution system, should not this inadequacy be taken care of when making the rates by considering the theoretical plant to be of proper size and such as to give good service?

MR. JOHN W. ALVORD: In that case if you were adjusting the whole subject of new improvements and new rates, you can very readily estimate the new construction that is necessary to provide for a given state of efficiency for a given population.

48-INCH CAST IRON FORCE MAIN FOR ATLANTIC CITY, NEW JERSEY

By L. Van Gilder

During the eight years of the writer's superintendency of the Atlantic City Water Department it has been his duty to design two forcing mains from the pumping station on the mainland across the intervening salt marsh to the city, a distance of about 26,000 feet.

A description of the first main was printed in the 1912 *Proceedings* of this Association and needs no further mention except to say that it is practically the city's sole dependence at this time and that it bids fair to fulfill the original expectation as to durability.

The second main, 48-inch cast iron, now building, is the subject of this paper.

To prevent the corrosive action of the salt marsh it was deemed advisable to elevate the main above the surface, a suitable foundation being the only obstacle.

The surface strata consist of soft muck of a depth varying from 5 feet to 25 feet constantly saturated with water to the grass roots and underlaid with sand, gravel and clay.

While this muck rapidly destroys iron and steel it is a preservative of wood and, therefore, particularly adapted for the use of pile foundations, provided the piles are not exposed to the atmosphere above the point of constant saturation.

The finished foundation consists of a double row of pine piles freshly cut from growing timber driven in pairs 3 feet 6 inches centers transversely and approximately 6 feet centers longitudinally. Each pair of piles is capped with a reinforced concrete bolster cover to fit the pipe, the bottom of the bolster being in breeching form to surround the piles and carried well below atmospheric action.

By this arrangement every length of pipe is carried on two bolsters supported by four piles.

The bottom is so irregular that the piles vary in length from 20 to 45 feet, the weight of the hammer being sufficient to sink a large proportion of them from 20 to 25 feet without a blow and others requiring a water jet to set them deep enough for lateral stability.

To provide for expansion and contraction due to temperature changes each spigot is held not less than $\frac{1}{4}$ inch clear of the bell shoulder by inserting a gauge ring in the joint; all gauges are withdrawn after the pipes are placed in permanent position. All joints are poured with molten lead not less than 3 inches deep and thus every pipe is carried on its own bolsters and is connected to adjoining pipes only by the lead joint rings.

As a safeguard against any possible chemical action between cast iron and concrete a $\frac{3}{16}$-inch gasket of hard fiber is placed between pipe and bolster.

Valves, manholes and blow-offs are placed at intervals of about 3000 feet to facilitate internal inspection and repair.

At the city end the main crosses a navigable stream about 500 feet wide with a 200-foot channel 12 feet deep at mean low tide.

This crossing will be made by a 48-inch bell and spigot inverted siphon with flexible joints at all deflection points, all laid on piling with timber caps. The entire structure to be below the present stream bed.

The bottom is beach sand and a 12-inch cast iron pipe 30 years old just removed from the same location is hard and in good condition.

The construction of this main contained so many uncertainties that it was deemed expedient to build it sectionally. The work was so successfully accomplished that the contract for the balance, except the thoroughfare siphon, was let November 6, 1913.

Every part of the work is being prosecuted with such vigor that we expect to have the main in service early in August of this year.

The anticipated difficulties have so far proven to be imaginary rather than real.

The piling has not exceeded the estimate and the proximity of the Pennsylvania and Reading Railroads has so facilitated the handling of materials that by the use of a work train and railroad derrick, pipe, piling, gravel, sand, cement, etc., have been distributed at the approximate cost of handling on the city streets.

The cost of the finished main will approximate $415,000 and the experience gained in building the first and smaller section together with a closer price for pipe, specials and valves has resulted in a net saving of about $65,000 in the cost of the last section, assuming that the unit prices in the first contract would have been the same had the whole project been included in the first letting while the cost per foot of main complete, including valves, valve housings, special castings and thoroughfare siphon will be about $16.

The original 6000 feet was completed early in October, 1913, and has stood empty since completion and test. As no serious disturbance is apparent in the joints we feel warranted in the assumption that ample provision has been made for temperature stresses.

The question has been asked "Why is it necessary to build a new main at this time if the wood stave main is successfully performing the work for which it was intended?"

The pumping station is located 5 miles from the city and the force mains must of necessity be built for the greater part of their length across salt marsh, under one or more railroads and across a navigable stream.

The chances of accident are too great to be ignored and the city cannot afford at any cost to have its water supply cut off.

Two of the old mains are abandoned and the third (20-inch cast iron) has so nearly outlived its usefulness that it has broken three times since work was begun on the last contract.

With the completion of the new main the city will be supplied by two independent lines, either of which will carry the load alone for a number of years to come, that cross railroads and streams on different rights-of-way and that will require two accidents in different locations simultaneously or in quick succession to cause the slightest danger.

NOTES ON THE CONTAMINATION OF A DRINKING AND RAILROAD WATER SUPPLY BY SEA WATER AND THE REMOVAL OF THE SALT WATER FROM THE RESERVOIR

By John R. Downes

Few incidents in the construction of the Panama Canal show more clearly the intricate complications which had to be met at every turn than that of the contamination of the Cocoli water supply by sea water.

Cocoli Lake was formed by the construction of the west toe of the Cocoli dam across the course of the Cocoli River. The water was diverted to the northward around the site of the Miraflores locks.

A shortage of water in the Rio Grande reservoir made it necessary to use these impounded waters of the Cocoli as an auxiliary to the water supply of the towns on the Pacific side of the divide, including Corozal, Ancon, Balboa and the native city of Panama.

When the pumping of silt from the sea level portion of the canal into core of the dam was begun, some uneasiness was felt by the sanitary department as to the effect of possible seepage of the salt water into the drinking water supply.

At the direction of the chief sanitary officer the writer, then in charge of the sanitation of the zone water supplies, kept a careful watch for any indication of the salt in the lake.

In spite of the fact that water from the lake had found its way through the toe of the dam into the core pit before hydraulic filling was begun, there was no corresponding flow in the opposite direction when the salt water was pumped into the core.

The average chlorine content of the lake water was 3 p.p.m. in October, 1910, 3.5 in November, 4.5 in December, 6 in January, 1911, the fill having been begun in September, 1910.

On November 1, 1910, fourteen samples were taken from the surface of the lake at intervals along the toe of the dam and eight samples from other parts of the lake. None showed more than 3.5 p.p.m. of chlorine.

Not until February 10, 1911, was there any marked increase in chlorine content of the lake. On this date the sample from the laboratory tap in Ancon showed a decided increase and an investigation at the lake resulted as follows:

Samples taken in a straight line across the lake at right angles to the toe of the dam showed p.p.m. Cl at the toe 94; one-fourth of the distance across 90; one-half the distance across 70; near the shore opposite to the toe 56.

On February 15 a slide occurred at the northeast corner of the lake (first point mentioned above). Samples were taken at intervals along the toe and along a parallel line extending through the center of the lake:

AT SLIDE NORTH END OF TOE	ALONG TOE	CENTER OF LAKE
Same as first point above (A).....	102	80
(B).....	78	78
(C).....	70	58
(D).....	70	60
South end of toe.....(E).....	58	

On February 20 a decided and sudden increase in the chlorine in Panama-Ancon tap water prompted another survey of the lake. Samples from points A, D, and E above contained 204, 208, and 202 parts of Cl respectively. Water from the pump, the intake of which was 9 feet below the lake surface, contained 358 p.p.m.

A report and warning were sent to the engineer in charge of the municipal work for the Pacific Division, who had been kept in touch with conditions constantly.

On the next day there was a vigorous protest from the transportation department, which reported all traffic in the Pacific Division delayed by the foaming of the boiler water. During the next few months serious trouble from foaming occurred whenever the chlorine went above 70 p.p.m.

On February 22 water containing 440 p.p.m. Cl was being pumped into the mains at Cocoli. Tap water in the city varied from 100 to 400 with the fluctuation in the quantity of water being supplied by the two sources, Cocoli and Rio Grande.

An emergency pumping station was set up on the Camatillo River, the only other available supply, but an unprecedented draught rendered this source pitifully inadequate.

The 16-inch main from Rio Grande was taxed to its limit and to increase the flow by an auxiliary main was not only too slow, but threatened to drain the reservoir before the end of the dry season.

The lock work at Miraflores and Pedro Miguel, the power house at Miraflores, transportation of the spoil trains from Culebra cut, the dock work at Balboa and the fire protection of the city were all at stake. There was absolutely no choice but to use salt water and make the best of it.

Locomotives, so far as possible, were watered in the other divisions or from the Rio Grande supply above the point of entrance of the Cocoli water. Of course there were strenuous objections from the public at the use of the brackish water, but even the international aspect, brought about by the remonstrances of the Panamanian government, could not be permitted to interfere with the progress of the canal, so the public drank the water and survived.

One curious incident nearly proved fatal. A surgeon who had been using the tap water, sterilized, for making injections in the treatment of syphilis, found one of his patients sinking rapidly under the influence of the salts on the patient's blood. He was able to bring the patient through, however, and thereafter the laboratory supplied distilled water for this use.

We were now confronted by two problems, to stop the leaks and to get rid of the salt already in our water supply. The first was accomplished without much difficulty by dynamiting the south end of the toe over the old river channel and reinforcing the south end where the slide had occurred, between an old fill and a new one, with a puddled core.

Investigation showed that large bodies of salt water had moved through the body of fresh water for distances of 1000 and even 1500 feet, finally settling in isolated deep holes where as much as 6000 p.p.m. of chlorine were found.

On March 25 the Pacific Division put into operation a 2,000,000-gallon pump with the intake at 13 elevation. The idea was to pump out the heavy salt layers from the bottom. The Cl in the discharge from the pump at 24-hour intervals follows:

March 25, 4250; 26, 3300; 27, 2500; 28, 2200; 29, 1950.

The writer suggested that the pump be run only 12 hours per day so as to permit the heavy salt layers to work towards the pump during the shut down. With constant running the upper layers with little salt in them found there way to the intake. The sugges-

tion being followed, the chlorine in the discharge fell to 1550 and remained at this point until the pump was removed on May 4.

On February 20 the chlorine had diffused across the lake and up into the river. The point where the river widens into the lake is about three-fourths of a mile from the leak and here the Cl was 29, while at the first falls in the river, a mile further up stream, it was 25.

Soundings were taken on the next day and the vertical distribution of Cl was found to be as follows:

ELEVATION ABOVE SEA LEVEL	CHLORINE; PARTS PER MILLION	APPROXIMATE QUANTITY OF WATER IN GALLONS
36.00	420	
31.00	420	
26.00	480	
25.75	520	254,000,000
25.50	600	
25.00	600	
24.50	680	
23.50	750	67,000,000
21.00	920	
18.00	1,300	33,500,000
13.00	3,750	
11.00	4,250	10,000,000
6.00 lowest point in lake	5,250	1,000,000

There was in the lake on April 15 about 365,000,000 gallons of water containing 3,000,000 pounds of sodium chloride, or its equivalent, and 4,200,000 pounds of other salts. Of the sodium chloride 2,200,000 pounds were contained in approximately 11,000,000 gallons of water, below elevation 15. This quantity lies in numerous deep pockets below gradient of the old stream bed.

The specific gravity of the water below elevation 10 was 1.008, there was perhaps a million gallons of this.

The water between elevation 10 and 15 (10,000,000 gallons) S. G. = 1.005.

Water between elevation 15 and 21, S. G. = 1.002.

From these facts it was evident that unless each individual deep pocket was pumped out separately, 66 per cent of the salt present could not be directly affected by any amount of pumping.

Diffusion was arrested and the water remained stratified whenever the Cl in the surface layers reached 500 p.p.m. approximately.

It was figured from this data, that if all the water above the gradient of the stream bed, were displaced by fresh water, there would again be 500 p.p.m. of chlorine in the surface water as soon as equilibrium was reëstablished up to the point where diffusion seemed to be arrested, and that only on the third complete displacement could the water be expected to come again within the limits of potable water.

It was concluded that the only way to get satisfactory water within a reasonable time was to drain the lake completely, using the running river water above as a supply in the meantime.

In the meantime work previously planned had been going forward and the spillway had been raised 8 feet. With this increased volume of water a new equilibrium was established, the surface water taking chlorine to the extent of 150 p.p.m.

Before we could put our plans for draining the lake into operation the situation was relieved by a torrential, cold rain. The temperature of the river water flowing into the lake was 4°C. below that of the lake water. The difference in gravity, due to temperature, overcame the difference due to the presence of the salt, permitting the cold fresh water to slip in, as it were, between the lighter salty strata in the upper levels of the lake and the dense salt solution at the bottom. This fresh water settling directly on top of the strong salt solution absorbed the salt very rapidly. The vertical distribution of Cl a few days after the storm is shown below and at the right a hypothetical condition which must have occurred in the interim:

ELEVATION ABOVE SEA LEVEL	TEMPERATURE DEGREES C.	CHLORINE P. P. M. OBSERVED	HYPOTHETICAL
41.7	30	150	150
34.7		130	150
31.7	28	110	150
24.7	26	70	
18.7	26	80	000*
16.7	26	140	
15.7	26	560	1,300
12.7		3,000	3,000
5.7		5,250	5,250

*Indicates that a stratum of water, of indeterminate thickness and position, was for a time free from chlorine though suspended between two strata of salt water.

Previous to this rain a drainage pump of 16,000,000 gallons daily capacity had been in operation, 12 hours a day, for six days. The record of chlorine in the discharge from this pump at 24-hour intervals follows; 1000 p.p.m., 850, 750, 650, 550, 450. Here the storm referred to occurred and the chlorine in the pump discharge dropped to 100, coming back to 250, it again settled to 140 where it remained, the whole lake above elevation 16 now being uniform at that figure. Pumping was then stopped as nothing could be gained by pumping that could not be as well accomplished by letting the water waste over the spillway.

On July 31 it was estimated that there still remained in the lake 1,250,000 pounds of (sodium) chloride as against 3,000,000 pounds on April 15. The removal of the difference had been as follows:

	(Sodium) Chloride pounds
Removed by small drainage pump March 25 to May 4	1,277,000
Removed by regular consumption April, May, June and July	642,000
Removed by large drainage pump July	296,000
Estimated remaining July 31	1,249,000

NOTE. Approximately 614,000 pounds had been removed by small pump previous to estimate of April 15.

As to how small a quantity of chlorine in a water will make it taste salty, there were differences of opinion, when water containing sodium chloride to the amount of 350 p.p.m. was given to the various laboratory employes. Less than this quantity was not detected. However, sea water added to tap water to give 200 p.p.m. Cl was very unpleasant to most persons.

Some persons complained of a nauseating and burning sensation of the stomach when using water with over 200 parts of chlorine. The writer experienced this several times when the water was not thoroughly iced.

No more serious effects on the human system were observed, although water with from 200 to 400 parts Cl was delivered regularly for three months.

THE GROWING VALUE OF GROUND WATER SUPPLIES

By L. J. Le Conte, C.E.

The writer wishes to call the attention of members to the fact that as the population in any district increases annually and the troubles from contamination necessarily grow worse, the intrinsic value of ground water supplies increases correspondingly. The natural growing troubles due to density of population have led many large cities in Europe, as well as this country, to abandon their old surface water supplies, and they have gone back to the old original ground water supplies as being the best and safest and this conclusion has been reached after long years of sad experience.

It is true that ground water supplies are surrounded by grave doubts as to their capacity in a long season of protracted drought. The sum and substance of the whole business is this, that in all such cases the best teacher is broad experience. This teaches us that in cases where you have *ample capacity of gravel beds* to store up the available waters, the *maximum supply possible*, in any case, will be 25 to 30 per cent of the *long average rainfall.* In a great many cases, however, the capacity of the gravel beds is inadequate to store up and hold all the available waters and as a final result you will only get the volume of water that the gravel beds will naturally hold and no more. Hence it is that in a great many cases you only get 8 to 10 per cent of the average rainfall, simply because your gravel beds are not large enough to hold all the available waters.

In arriving at the volume of storage in the gravel beds a great deal of conservatism should be exercised. After you have carefully figured out the total volume of the gravel beds, then assume that half of this will be lost by reason of underground topography, then assume that the voids in the balance will be one third, hence we have $\frac{1}{2} \times \frac{1}{3} = \frac{1}{6}$ the total volume of gravel beds is available for storage of water and $\frac{1}{4}$ average rainfall is the maximum water available.

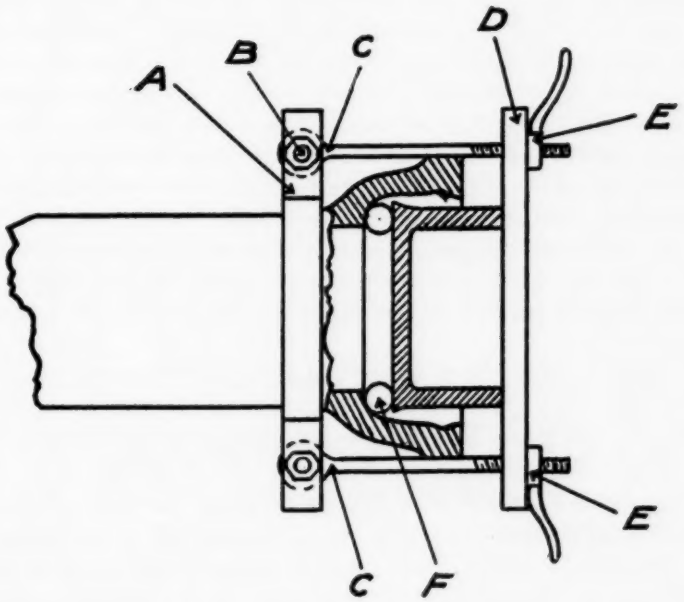
Storage reservoirs for *surface waters* on the Atlantic Coast catch $\frac{1}{4}$ R″ rainfall for *three driest years in succession.* On the Pacific Coast they only get $\frac{1}{8}$ R″ rainfall for *three driest years in succession.*

Catch = $\frac{1}{4}$ R″ *long average rainfall.* Hence the gravel bed reservoirs have naturally a *much greater annual catch* ceteris paribus and are much less liable to contamination. Moreover, the possibilities of expansion of the supply, when needed, by artificial means are quite possible and in some cases very material. This can be done by temporary surface storage in the watershed above and distributing ditches over the gravel beds and by deep-well artesian flow in the bed of the valley.

A CHEAP HOME MADE TEST PLUG FOR WATER MAINS

By W. E. Haseltine

The construction of this test plug will be self-evident from the sketch herewith. It consists merely of a clamp *A* surrounding the pipe directly back of the bell. Attached to the bolts which fasten this clamp together are eye bolts *C* with long threads.



These eye bolts extend through holes in the bar *D* and are supplied with long threads to receive the wing nuts *E*. A ring of ½-inch or ⅝-inch rainbow tubular manhole gasket *F* is put into the bell and against this is placed an ordinary cast iron water main plug. The wing nuts *E* are then turned down, clamping this plug against the gasket by means of the bar *D*.

The entire adjustment can be made in a few minutes and the cost

of the outfit is negligible. With the exception of the clamps, the same outfit can be employed for various sizes of pipe by having the bar *D* long enough for the largest size and drilling holes at various points in its length. This clamp has proved very satisfactory in service.

PUSHING SERVICE PIPES UNDER PAVEMENTS

By F. C. Amsbary

Champaign and Urbana, Illinois, the municipalities we serve, with a combined population of 25,000 have a large percentage of their streets paved. It is the practice of our company to lay all water mains in the parking, that is, between the curb and the sidewalk. Before beginning the pushing of the service pipe it is necessary to dig a trench about 18 feet long, to take a full length of galvanized wrought iron pipe, the material we use for service pipe. The pipe pusher is first laid in the trench and fastened down by means of wooden stakes. It consists of an iron frame on which is a steel carriage. The pipe is laid in position on the carriage and fastened securely by a locking device. The carriage and pipe are moved forward by means of a ratchet with a long handle, the carriage travelling about 2 feet. When it has reached the end of the frame the locks are released, leaving the pipe and carriage free and carriage is moved back and pipe is again locked. This operation is repeated until the pipe has gone the required distance. In order to keep the pipe from drifting out of the straight line we turn it frequently with an ordinary pipe wrench. We seldom have any trouble in pushing the pipe to the point desired.

The soil in our streets is, in most cases, heavy clay; in sandy soils of course the pushing would be much easier.

When we have a leak in the service pipe under the pavement, instead of tearing up the pavement to repair it, we push a new service through and abandon the old one, finding it much cheaper than digging up the pavement and re-laying it, and, what is equally important, we help preserve the pavement; for no matter how well done, a pavement can not be put back quite as good as it was before.

The advantage of laying water and gas mains in the parking is not well understood by many water works people. The writer has known cases in neighboring cities where paving jobs have been held up, waiting for the water company to lay its mains, when there were wide parkings on either side of the pavements, where the mains should be laid. With the mains in the parkings the pavements will never be disturbed by reason of leaks and putting in new services.

There are several good pushing devices on the market.

LABORATORY CONTROL OF WATER SUPPLIES

By Dr. Edward Bartow

In Illinois the State Water Survey has been promoting the establishment of laboratories for the chemical and bacteriological control of the water supplies wherever such control is needed. During the last few years a number of water works in the state have established such laboratories. Sometimes it has been difficult to show the various water works operators, whether in the employ of companies or municipalities, the value of water analyses made either by themselves or by our laboratory.

The point of view that sometimes prevents the installation of laboratories may be illustrated by one of our experiences. An old gentleman over seventy years of age obtained from the laboratory the necessary bottles for the collection of water from his well. A few days later he brought back the bottles, stating, "My wife won't let me have the water analyzed for you might condemn it and then she could not drink it any more."

Many of the operators, however, are easily persuaded to install laboratories and those who have installed them have been delighted with the results.

It is not our purpose to discuss at length the control of large water supplies. The owners can employ their own experts and can establish the necessary laboratories for control. They will, of course, have a bacteriological laboratory that will contain all that is needed to make bacteriological investigation. They will have a sanitary-chemical laboratory containing the equipment necessary for sanitary-chemical analyses. They may even have a laboratory for the determination of the mineral content of the water; for such determinations are often necessary when waters of varying composition from a river or from a combination of several sources have to be treated. One suggestion with regard to such laboratories is: do not make the rooms too large. A compact arrangement increases efficiency.

In Illinois there are very few plants exceeding 5,000,000 gallons daily capacity. We recommend simple laboratories that are suit-

able for such small plants, where the operators hesitate to undertake extra work that will require extra help. We must also, necessarily, advocate only the simple and necessary tests. The simplicity of the outfit required is illustrated by one of the smallest laboratories (Fig. 1) in the state of Illinois, or even in the United States. This is a laboratory for the control of the iron removal plant of the Champaign and Urbana Water Company. The water treated is from deep

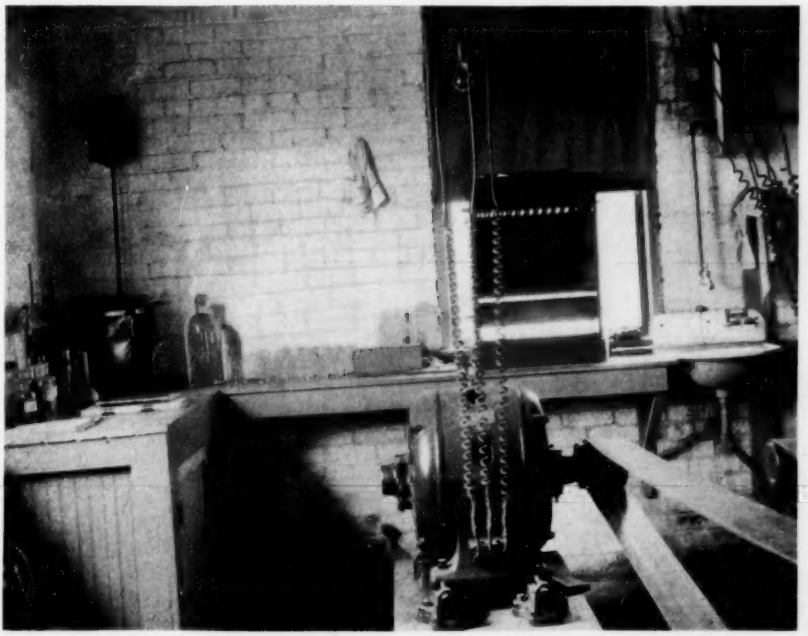


FIG. 1. LABORATORY IN IRON REMOVAL PLANT OF CHAMPAIGN AND URBANA WATER COMPANY.

wells and contains no bacteria. The chemical constituents are constant, therefore, the test for iron is the only one required. The necessary apparatus consists of a few collecting bottles, bottles for re-agents, a burette and some pipettes. These are installed on a simple laboratory table in one corner of the pump house.

For the control of filter plants using river water a more extensive outfit is needed. Tests for number of bacteria, gas forming bacteria, turbidity, color and alkalinity must be made. Several laboratories

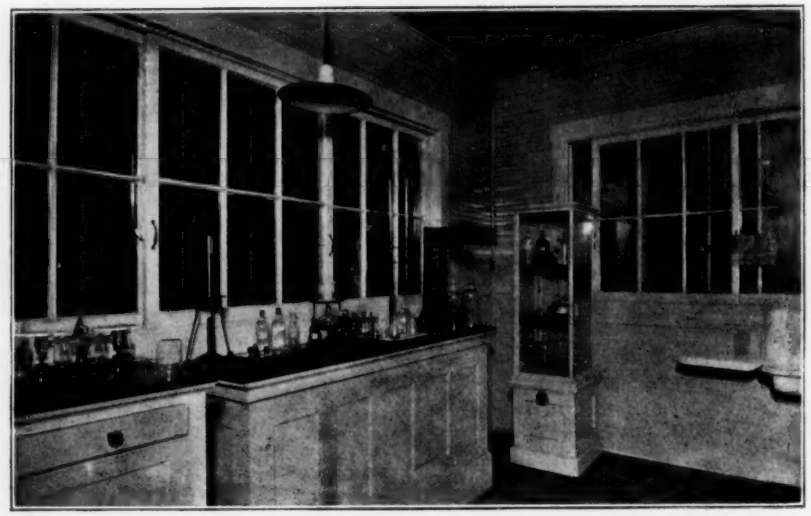


FIG. 2. LABORATORY OF CAIRO WATER COMPANY.

FIG. 3. LABORATORY OF DANVILLE WATER COMPANY.

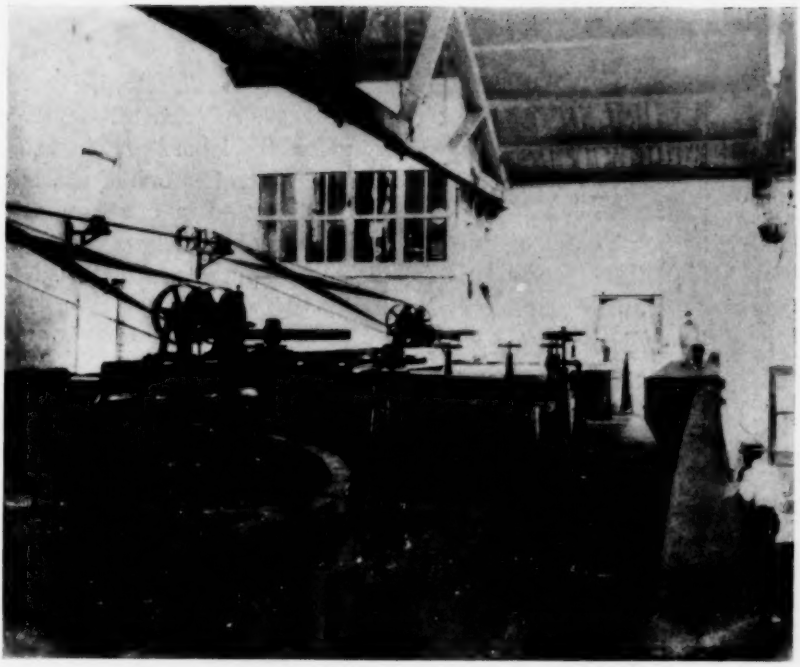


FIG. 4. LABORATORY BUILT IN FILTER HOUSE, PONTIAC.

FIG. 5. OFFICE AND LABORATORY, DANVILLE WATER COMPANY.

of this type have been established and have given satisfaction. Good examples are at Cairo (Fig. 2), and at Danville (Fig. 3).

It often seems difficult to find space for the laboratory, but the difficulty can be overcome. At Pontiac, which has one of the old style plants, the laboratory has been constructed in one corner of the filter house (Fig. 4) and partly over one of the filters. It is 9 by 14 feet in size, and contains sufficient apparatus for the satisfactory control of this small plant.

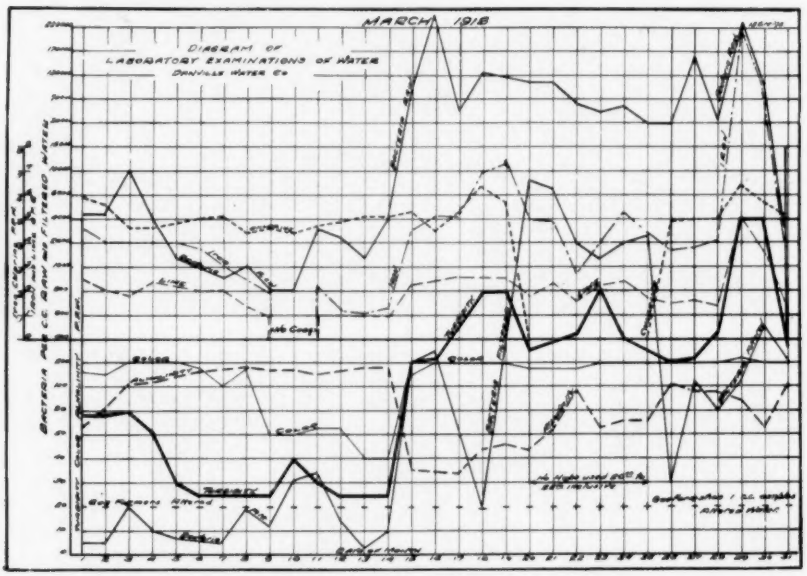


FIG. 6. DIAGRAM SHOWING CHEMICALS USED AND THE NUMBER OF BACTERIA FOUND MARCH 1913, DANVILLE, ILLINOIS.

More elaborate structures may be erected. The Danville Water Company recently constructed, adjacent to the plant, a building for an office and laboratory (Fig. 5) that adds considerably to the attractiveness of the plant. Charts are prepared each month by Mr. H. M. Ely of the Danville Water Company, to show the results obtained by this laboratory. The chart for March, 1913 (Fig. 6), has been reproduced in order to show some of the results which impressed upon the minds of the operators the necessity for complete and continuous control. The amount of bleaching powder is indicated by the available chlorine, which was discontinued on the

twentieth and was not used for the following six days. During this period the number of bacteria, as indicated, increased very largely, dropping as soon as the use of the bleaching powder was resumed.

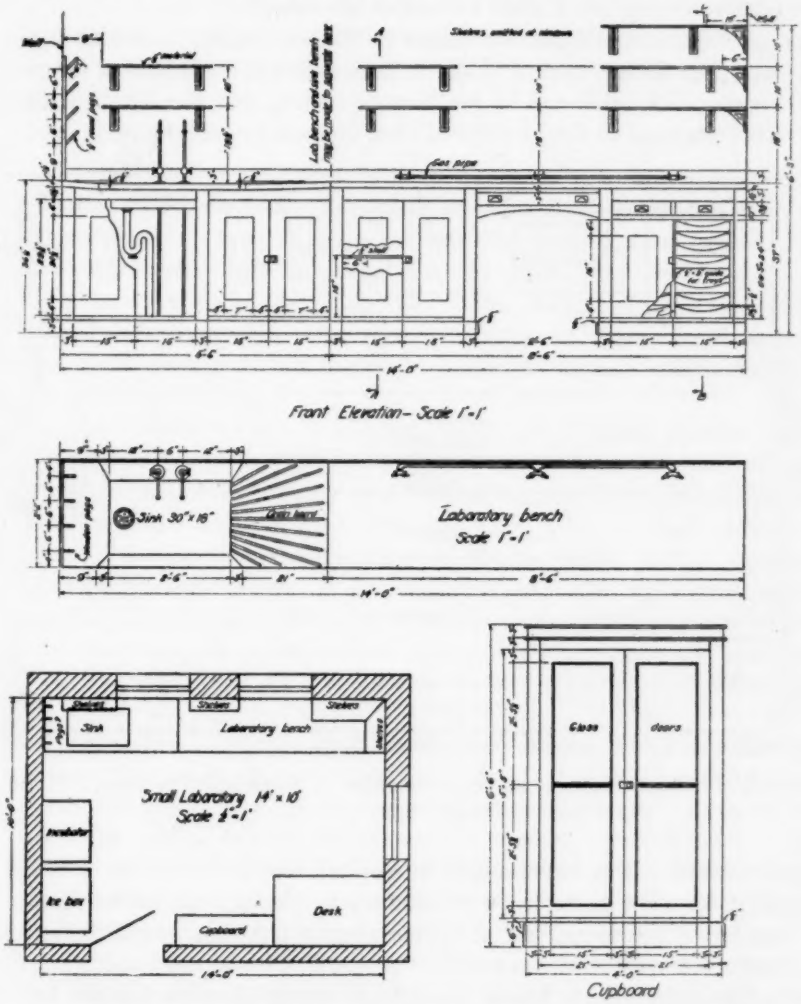


FIG. 7. PLAN OF SMALL LABORATORY AND DETAIL OF TABLE.

Positive tests for the gas formers were also evident during this period, and ceased immediately on the resumption of the use of the bleaching powder.

In order to assist operators in establishing laboratories, a list of the necessary apparatus and chemicals has been prepared.[1] The list is so arranged that an operator can choose what is needed for a small laboratory, or, for a more extensive laboratory.

A diagrammatic plan showing the fixtures needed in a small laboratory (Fig. 7) has been of value to those who have established laboratories. The table can be easily constructed, and the detailed plan has been used as the basis for several laboratory tables now in use in

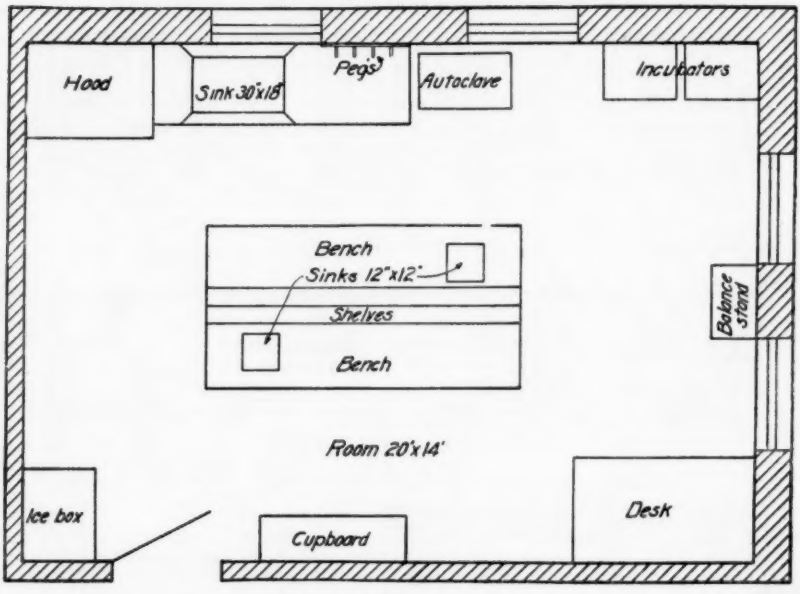


FIG. 8. PLAN SHOWING AN ARRANGEMENT OF FURNITURE IN SMALL WATER WORKS LABORATORY.

the state. If a larger outfit is desired, the table can be doubled (Fig. 8). For example, two units may be placed back to back in the center of the room, and the remainder of the furniture distributed around the sides of the room.

The suggestions which have been briefly described have been accepted by several of the water works operators, and we think we can safely say that those who have established laboratories and given them a thorough trial would be unwilling to dispense with them.

[1] *University of Illinois Bulletin*, Water Survey Series No. 8.

SOME RELATIONS BETWEEN THE WATER SUPPLY AND TYPHOID FEVER IN WASHINGTON, D. C.

By John Gaub

Typhoid fever, through its death rate, has proven to be the best index of the quality of the water supplied in American cities. Especially is this the case when the rate is in excess of a certain amount. Owing to the fact, however, that typhoid fever is traceable to causes other than water and that contamination of supplies is generally of progressive occurrence, this relationship as is well known to sanitarians does not readily or uniformly appear in the charts of typhoid fever rates.

To understand the conditions relative to typhoid in some communities it is essential that a discrimination be made between the normal seasonal typhoid and the abnormal prevalence due to certain conditions. This discrimination is quite essential when we recall that in many of the cities of the north the normal seasonal prevalence of typhoid is lower during the late winter and early spring than at any other season of the year; the reason for which is, that with the exception of water-borne infection the agencies of infection such as vegetables, fruits, contaminated milk, fly troubles, etc., are less active.

It is evident, however, that flood conditions which are always more intense in the early spring, constitute a serious danger to water supplies taken from surface streams and lakes. Even when a watershed is sparsely populated the washings during floods may bring down to a water intake contamination and infection from indirect sources, causing the infection, which may have been latent upon the watershed during the year, to become active.

It has been shown many times that decided decreases in the mortality from typhoid fever in cities having contaminated supplies usually followed the installation of a purification plant, and that similar decreases have followed the changes caused by a transferral from a contaminated supply to one less exposed to contamination.

In considering the typhoid death rates of Washington for some years previous to filtration and after filtration, two facts at first

present themselves, viz. (1) the rates tend to group themselves, i.e., the improvement appears to have been in periods; (2) the year after filtration does not agree with the general tendency and effect of filtration as is seen in other communities.

TABLE 1

Year	*Rate per 100,000*	
1898	64.3	
1899	67.2	
1900	74.0	
1901	56.3	
1902	74.0	
1903	45.0	The periodical improvement as seen from the table and curve, up to the year 1913 is, no doubt, due to the improvement in the water supply.
1904	44.0	
1905	44.0	
1906	45.4	
1907	33.1	
1908	35.7	
1909	33.7	
1910	23.3	
1911	21.1	
1912	22.8	
1913	16.2	

Should the year 1906 be compared with 1905 and with the results of communities having safe water supplies, it will be seen that the curve representing 1906 approaches the curve for the communities having safe water supplies, more than does 1905, especially in late winter, although the rate is somewhat high. Again, the reason for the rate for 1906 may be derived from the fact that the mains wherein the water was served during the year were not cleaned as is customary in all communities when a good water supply has been installed; on the other hand the fact that 1906 was a typhoid year should not be forgotten; and, for these reasons in the mind of the writer, the year 1906 should belong to the years previous to the installation of the filter plant. With this assumption, or fact, in mind, the work of the plant meets all generalities that have been derived from other communities when a filtration plant has been installed.

As is well known the mere absence or presence of coli in a fixed amount of water may have no significance when considered without regard to other circumstances. Most sanitarians are aware of the fact that coli are common to nearly all of the higher and lower animals. However, in reference to coli in water from human sources

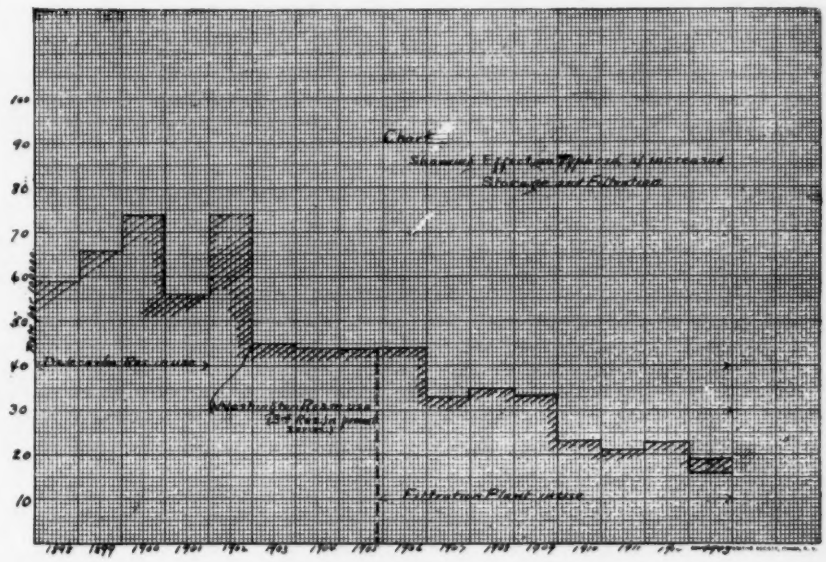


PLATE 1

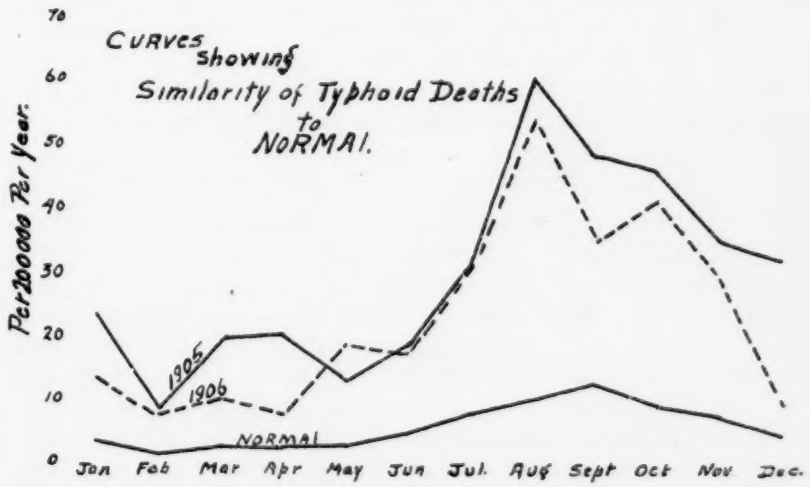


PLATE 2

it must be remembered that the population on the watershed has some influence, and for this reason, in addition to the mortality, the case incidence should have its place when comparisons are made, the effect on the ratio being due to the influence of the case incidence on the carriers. In Europe the incidence is lower and the case mortality is higher than in this country, so that the significance of coli in this country means more than in Europe. Yet it has been stated that the B. Coli content of a water does not bear a constant ratio to the typhoid rate and hence is not so important as might be expected. This statement is partly true, yet it should not be forgotten that coli do not prove the absence or presence of pathogenic organisms in a water supply, but that it is an inferential test of the danger and injury to the public health. However, when the coli content of the water per 100 cc. is averaged per month and these results compared, by means of a curve, with the averages per month of the deaths, a similarity between the two ensues for the first six months, after which the two curves depart showing that the water with its very small content of coli, if present, had no effect on the typhoid, and hence the typhoid was not wholly caused by the water supplied during that time.

Some sanitarians have, in times past, thought that the Potomac and streams south of it were different from those in the north, in that it was possible for them to cause an all-year round typhoid. This, no doubt, is contrary to the results of many investigators who have found that the death of the organisms of typhosus and coli increased with the temperature. However, to show that the typhoid of Washington does not differ from that of a northern city, the writer has plotted the typhoid rate of Toronto in comparison with that of Washington, before and after filtration, and on close examination it will be seen that the two curves are quite similar, showing that there is not much difference between the causes of typhoid in Toronto and Washington.

Again, if the rates are plotted in periods, as they appear in the table, in comparison with the normal, it will be seen that the curve for the period 1910–12 follows that for the normal quite closely. Of course the normal curve is somewhat lower than it would be were only the water supply considered, for in the cities from which it is taken there has been considerable improvement in the milk supply, fly campaigns, etc., in progress for several years, so that if a certain factor were added to the rates in these cities there would not be the difference possible as is seen from the curve.

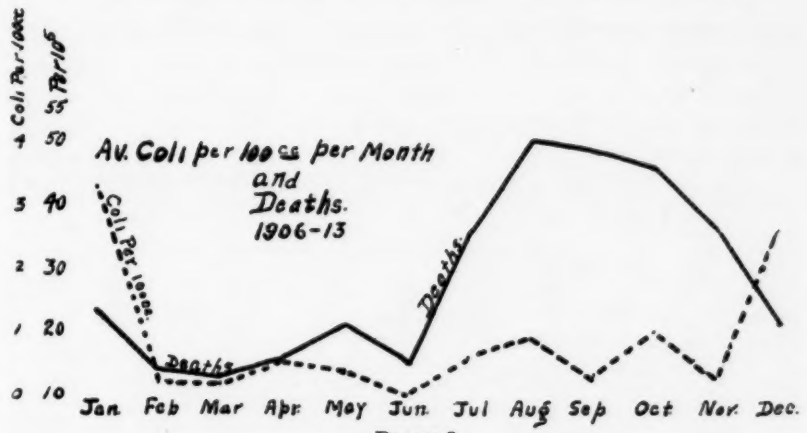


PLATE 3

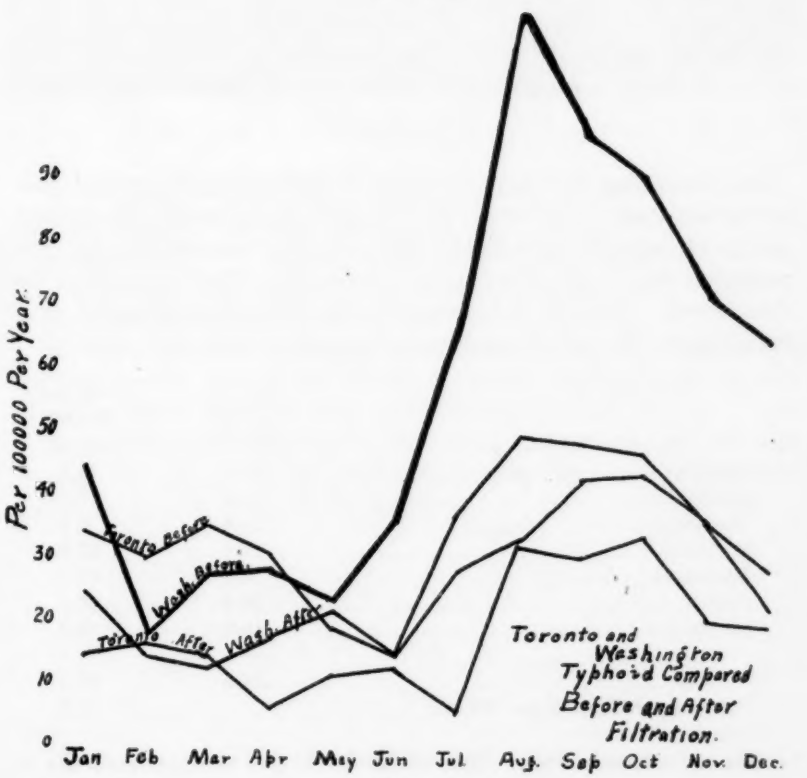


PLATE 4

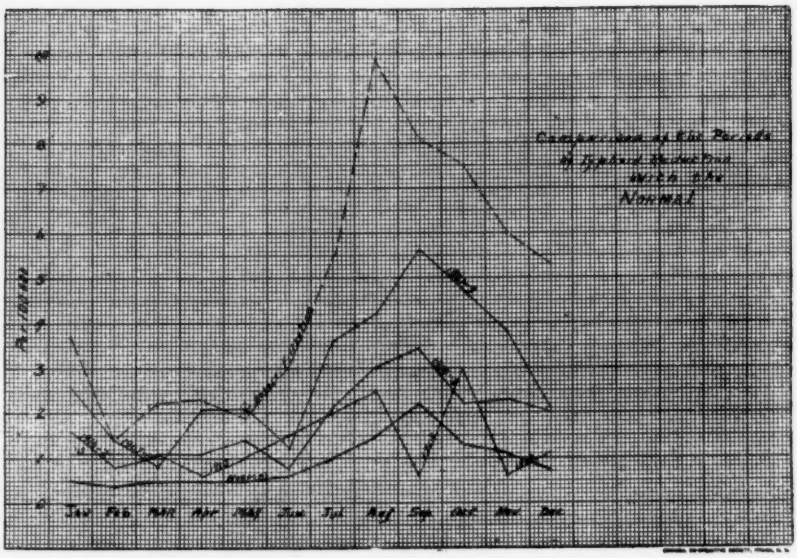


PLATE 1a

In considering the improvement in typhoid rates, several factors other than water enter; and in order to determine the results due to an improvement in the water supply it is essential that the reduction due to improvements in sanitation other than water be determined. For this determination the writer has compiled data from those cities which have no water purification.

City	*Rate per 100,000* 1906–10	*Rate per 100,000* 1911–12
Buffalo	25.2	18.6
Detroit	21.3	17.5
Newark	15.8	8.5
Portland	24.1	17.5
Rochester	15.0	11.5
Seattle	25.4	9.0
St. Paul	18.0	9.5
Total	144.8	92.1
Average reduction per 100,000		7.5

The reduction in these cities, no doubt, is due to improvements in sanitation, practised mostly in the summer months. Hence if a

similar factor is applied to the rates for 1910, 1911 and 1912 in Washington, a rate very reasonable and quite similar to that obtained in 1913 when a fly campaign was in progress is obtained; thus showing that the plant has been a factor in reducing the typhoid rate, and that other sources of the infection should be sought.

Year	*Rate*		*Rate after correction*
1910	23.3	minus 7.5	15.8
1911	21.1	minus 7.5	13.6
1912	22.8	minus 7.5	15.3
1913	16.2	no correction	16.2

From these figures it appears evident that the year 1912 might be taken as the dividing line for the improvement in typhoid due to filtration, while for the year 1913 the improvement is practically due to the fly campaign that was carried on successfully. However, should the correction, as above, be made, the rate in Washington would be considered good.

CONCLUSION

1. The purification of the water supply was a big factor in reducing the typhoid rate in Washington.
2. The year 1906 should not be considered as a year in which filtered water was supplied, due to the fact that the mains were not cleaned before turning in the water.
3. The typhoid in Washington is not caused by the Potomac for twelve months in the year, as was formerly thought, and hence it does not differ from that of a northern city.
4. Considering the various factors which comprise the field of sanitation, the rate in Washington is no higher than that of any city having a good and safe water supply.

NOTE ON ORTHO-TOLIDIN TEST FOR FREE CHLORINE

By W. F. Monfort

Developments in the use of chlorine and hypochlorite treatment of public water supplies have enlarged the importance of methods of test for residual chlorine in the finished water, to which the paper of Ellms and Hauser (Jour. Ind. & Eng. Chem., October, 1913) is the most valuable contribution. Some experimentation by the late Dr. L. P. Kinnicutt in connection with the now celebrated or almost forgotten Boonton (N. J.) case is of considerable importance in this connection. His results are buried in the mass of reports on this case (In Chancery of New Jersey:—Jersey City vs. Jersey City Water Supply Company, Vol. 12, page 6921 et ff.) which are available to but few members of this association.

In correspondence with a number of water works chemists within the past few months it has developed that a large proportion of those addressed were unable to refer to Dr. Kinnicutt's work, and were repeating or were about to repeat unnecessarily a volume of work well done by him. It seems advisable, therefore, to make available the substance of this work, and the author asks permission to introduce it into the proceedings of this association, quoting without further comment the full concise text of his conclusions, and tabulating the experimental data on the sensitiveness of this reagent recalculated to parts per million.

The reagent as used in these experiments was prepared according to directions proposed by Prof. E. B. Phelps, as follows:

0.5 grains placed in a mortar, ground up with 10 ccm. 0.1 to 1 sulphuric acid. Transferred to a beaker, washed out into a mortar with 250 ccm. water, added 10 ccm. concentrated sulphuric acid, heated to boiling. Color deep pink, perfectly clear. Transferred to 500 ccm. tincture bottle. On standing cloudiness appeared. Filtered through asbestos.

STUDY OF THE ACTION OF CHLORINE AND OXIDIZING AGENTS ON ORTHO-TOLIDIN. FOR THE JERSEY CITY WATER SUPPLY COMPANY. SEPTEMBER, 1909.
(OFFERED ON PAGE 6546.)

Ortho-tolidin. A homologue of benzidin, different from benzidin by the replacement of two hydrogen atoms by two methyl groups (CH_3).

(Graphic Formulae given.)

Ortho-tolidin is prepared by reduction of ortho-nitrotoluene by zinc dust in alkaline solution, and treating the azo compound formed with stannous chloride in acid solution. It is purified by recrystallization.

The reaction of various substances with benzidin have been carefully studied, but comparatively little attention has been paid to ortho-tolidin, but from our knowledge of organic compounds its behavior to various reagents, especially oxidizing agents, would be similar to that of benzidin.

In 1874, Schultz (Ann. 174, 226) showed that benzidin gave very delicate color reactions with oxidizing agents, and found that with chlorine final product of such oxidizing was a red substance insoluble in water but soluble in alcohol.

In 1881, Claus and Richter (Ber. 14, 82) studied the action of bleaching powder on ortho-tolidin and obtained an oxidation product, which however was not pure, always containing lime and also chlorine.

In 1902, Arnold and Mentzel (Ber. 35, 1328) called attention to the fact that benzidin could be used for detecting ozone, nitrogen dioxide and the halogens.

In 1904 (Ber. 37, 3761), Wilstatter showed that on mild oxidation a green colored and also a yellow colored substance were formed. That the yellow compound was of a quinone nature.

In 1905 (Ber. 38, 1238), Willstatter showed that the yellow compound was formed by oxidation; also with silver oxide and lead peroxide, and that it was an oxidation product containing two less hydrogen atoms than benzidin.

The action of oxidizing agents, including chlorine, on ortho-tolidin is undoubtedly similar to their action on benzidin, and consequently, the supposition would be that the yellow substance obtained was not (as supposed) due to substitutions of chlorine, but was due to the oxidation of ortho-tolidin. In other words, that the action of bleaching powder in this case was due to potential oxygen, as is the case when bleaching powder is used in water as a germicide.

That the production of this yellow substance obtained by the action of chlorine on ortho-tolidin is due to oxidation, namely to potential oxygen, is, I think, shown by the experiments that I have made with ortho-tolidin, which are given on pages 1–17.[1] These experiments show that ortho-tolidin is acted upon not only by chlorine with the formation of a yellow substance, but by various oxidizing agents such as ozone, nascent oxygen, sodium nitrite or nitrous acid, manganese persulphate, ferric salts, potassium permanganate, potassium bichromate, lead peroxide and sodium peroxide.

That with ozone, nascent oxygen and lead peroxide the delicacy of the reaction is so great that ortho-tolidin might serve possibly better than any other reagent for detecting these substances.

That it is also a delicate reagent for potassium permanganate and potassium bichromate.

That the reaction is somewhat less marked with sodium nitrite; still less marked with ferric salts, and least marked with ammonium persulphate and sodium peroxide.

---

[1] Reference is to pages of Dr. Kinnicutt's notes.

That the only oxidizing agents that were tried that did not give the yellow compound with ortho-tolidin were free oxygen and hydrogen peroxide.

The reason why hydrogen peroxide did not act in the same way as other oxidizing agents may be explained by the fact that in certain cases hydrogen dioxide does not act as an oxidizing agent, as is shown, for instance, by its action on silver oxide and potassium permanganate.

That the results obtained with commercial ortho-tolidin and with chemically pure ortho-tolidin were in general the same, but that the yellow color developed quicker when using C. P. ortho-tolidin and was a purer yellow and more easily detected than when using the commercial ortho-tolidin, due to impurities in this substance.

That for testing for available chlorine in water the potassium iodide test in my experiments indicated a smaller amount of available chlorine than the commercial ortho-tolidin test. (See experiments given on page 2.)

That the C. P. ortho-tolidin did indicate as small an amount of available chlorine in water as the potassium iodide test, but the ortho-tolidin test, in my opinion, even using C. P. ortho-tolidin is not so satisfactory as the potassium iodide test, as the pale yellow color is not as satisfactory a color to the eye as a light blue color.

That the ortho-tolidin test can in no sense be considered as a specific test for chlorine.

That there is no basis, either theoretical or experimental, for the idea that the yellow compound produced by the action of potassium permanganate on ortho-tolidin is due to the entrance of manganese into the compound, and I know of no case where the hydrogen of an organic compound has been replaced by manganese.

Respectfully submitted,
LEONARD P. KINNICUTT.

SUMMARY OF TESTS OF THE SENSITIVENESS OF O-TOLIDIN WITH OXIDIZING AGENTS

Oxidizing agent	*o-tolidin commercial*	*starch iodide*	*o-tolidin c.p.*	
Hypo solution	0.068	0.017	0.017	parts per million
Free chlorine				
Ozone	0.068	0.017	0.017	very delicate
Nascent oxygen	0.068	0.017	0.017	very delicate
Sodium nitrite	2.000			parts per million
Ammonium persulphate	200.000			
Ferric chloride	20.000			
Ferric alum	20.000			
Potassium permanganate	0.200			
Potassium bichrom	2.000			
Lead peroxide	3.000	less than 3 parts per million		
Sodium peroxide	5000.000			

INDEX.

Additions to distribution systems..... 250–259
Address of welcome Philadelphia Convention. By Hon. Rudolph Blankenburg..... 202
Address by President Thomas..... 205
Agar, advisability of substituting for gelatine as a medium for determining bacterial counts..... 11
Agar, compared with gelatine..... 526
Agar counts compared with gelatine for various coli conditions..... 13–16
Aggregate used in concrete work..... 352
Albany, N. Y., filter site at..... 467
reduction of typhoid by filtration at..... 34
slow sand filters at..... 33
Algae growths, effect of ozone on..... 629
Altoona, Germany, efficiency of filters at..... 31
Alumina sulphate best coagulant..... 487
American Public Health Association, adoption of agar for bacteria analysis by..... 11
Analysis, use of agar and gelatine in bacteria..... 11
Auburn, N. Y., legal decision in pollution case..... 688
rules for check valves at..... 95
use of liquid chlorine at..... 450
Automatic Sprinklers, as safe guards to human life..... 653
efficiency of..... 652
quantity of water used by..... 654
Avalon, Md., filters at..... 486
Bacteria, no method of getting quantitative estimates of..... 17
uselessness of percentage removal estimates..... 17
Baltimore Filter Plant, description of..... 497
Baltimore County Water and Electric Company filters at Avalon, Md.... 486
Belmont Filter Plant, Experiments with liquid chlorine..... 416
use of liquid chlorine..... 425
Bleach, comparison of with liquid chlorine at Torresdale filtration plant. 420
use of at Exeter, N. H..... 449
Boilers, how should house be cared for when water turned off..... 668
Boundary waters, pollution of by sewage..... 25
powers of joint commission on..... 25
Brief Review of Sewage Disposal Works in Some European Cities and Comparison with the Pennypack Creek Works at Philadelphia. Paper by George E. Datesman..... 359
Calcium hypochlorite at Torresdale filtration plant..... 404
Cast iron pipe, diagrammatic method of determining cost per foot..... 612

Cement, classification..... 350
first production in America..... 349
made by Egyptians..... 347
mixed or blended..... 351
natural..... 351
Portland..... 350
Pozzoulana..... 351
CHEAP HOMEMADE TEST PLUG FOR WATER MAINS, A. Paper by W. E. Haseltine..... 717
Check valves, double required on fire services at Auburn, N. Y..... 90
method of testing..... 92
on metered services..... 671
rules of Auburn water department for..... 92
specifications for..... 90
testing of..... 90
Chloride of lime, disadvantages of..... 408
experience with at Torresdale..... 403
reactions of..... 441
Chlorine, ortho-tolidin test for free..... 734
Cincinnati, Ohio, filter site..... 469
mortality statistics..... 487
rapid sand filters at..... 54, 473
Cincinnati, Ohio, results of rapid sand filters at..... 55
Coagulant, patent for granted to Hyatt in 1884..... 31
Coagulants, sulphate of alumina the best..... 487
used in mechanical filters..... 483
Coagulating chemicals..... 59
Coagulation, action taking place in..... 60
ancient use of..... 64
definition of..... 59
effect on hardness of water..... 66
in preparatory treatment of water..... 62
reasons for effect of..... 58
use in large settling basins..... 64
with sedimentation alone..... 65
Coli, counts on agar and gelatine..... 18
Colon-Bacilli, best indication of sanitary conditions..... 17
Columbus, Ohio, filter site..... 469
rapid sand filters at..... 57
Committees 1914–15..... June III
Committees, Philadelphia local..... 6
Comparison between cost of mechanical and slow sand filters..... 496
Comparison of gelatine and agar media..... 526
Comparative cost of filters..... 500
Concrete in water works construction..... 345
Concrete, expansion and contraction..... 356
mixing..... 355
placing..... 355

Concrete, proportioning 353
reinforcement 357
rendering water tight 356
water proof 356
Concrete in ancient construction 347
Concrete in modern construction 349
CONSERVATION OF POTABLE WATER AND THE DUAL SYSTEM OF DISTRIBUTION. Paper by Henry C. Hodgkins 554
discussion by F. W. Cappelen 563
J. N. Chester 558
H. C. Hodgkins 560, 564
D. D. Jackson 561
F. C. Kimball 562
F. W. Langstroth 561
P. A. Maignen 561, 564
Construction, metering water used for 683
Contact beds, in sewage disposal 369
Convention 1914
address of welcome by Hon. Rudolph Blankenburg, Mayor 202
address by President Thomas 205
attendance 193
exhibitors 193
minutes, committees, etc 195
Convention 1915, announcement 194
Cost of filters compared 496, 500
Cost of cast iron pipe, diagrammatic method of determining 612
Cost of water plants, local conditions an important factor 615
CROTON WATER SUPPLY: ITS QUALITY AND PURIFICATION. Paper by George W. Fuller 135
discussion by James M. Caird 180
J. M. Diven 176
D. W. French 175
G. W. Fuller 463
Frank E. Hale 179
Allan Hazen 180
Nicholas S. Hill, Jr 177
George A. Johnson 182
Dr. William P. Mason 174
Alexander Potter 456
Croton aqueduct, description of 137
hydraulic gradient of 161
Croton filters, details of design of 162
Croton water, average quality 1912 141
connections to city 137
cost of protection of water shed 172
microscopic organisms in 144
quality of 140
turbidity of 146

Croton water, turbidity of as effected by Catskill supply 160
use of hypochlorite with 150
Croton water shed 136
Darnell, Major C. R., introduction of liquid chlorine in water sterilization 415
DeMare sterilizer 566
Death rate reduced by filtration 516
Decarbonization of Croton water 162
Detroit river, pollution of 28
DIAGRAMMATIC METHOD OF DETERMINING THE COST PER FOOT OF CAST IRON PIPE. Paper by W. E. Miller 612
DISINFECTING 200,000,000 GALLONS OF WATER A DAY—EXPERIENCE WITH CHLORIDE OF LIME AND LIQUID CHLORINE AT TORRESDALE FILTRATION PLANT. Paper by Francis D. West 403
discussion by J. W. Ackerman 450
H. F. Huy 451
C. A. Jennings 453
G. A. Johnson 454
W. F. Montfort 446
R. S. Weston 448
G. C. Whipple 455
Distribution systems, additions to 252–259
information relative to 245
Dual system of distribution 554
Economy in ordering hydrants 539
EFFICIENCY OF HOUSEHOLD FILTERS IN CHICAGO. Paper by Arthur Lederer and Frank Bachman 589
discussion by J. M. Diven 600
W. F. Montfort 601
S. T. Powell 601
Frank L. Rector 600
Election of officers 212
Electrolytic action on pipes 250, 259
Electrolytic sodium hypochlorite at Torresdale filtration plant 403
Elmira, N. Y., typhoid fever at 485
EQUITABLE HYDRANT RENTALS AND BETTER METHODS FOR APPORTIONING FIRE PROTECTION COST. Paper by John W. Alvord 95
discussion by J. W. Alvord 699, 700, 702
J. D. Barnett 697
Albert Blauvelt 699, 700
Oscar Bulkeley 697, 702
J. N. Chester 545
W. C. Hawley 541, 700
H. C. Hodgkins 698
Alexander Potter 538
A. A. Reimer 698
Exeter, N. H., use of liquid chlorine and bleach 448
Filter plant, design of for New York 153

Filter plant, difficulty in securing proper managers for..... 30
Filter sites, Cincinnati, Ohio..... 469
Columbus, Ohio..... 469
Pittsburgh, Pa..... 467
Torresdale, Philadelphia..... 468
Filter sites for Croton water supply..... 469
Filtered water, population of United States supplied with..... 73
Filters, at Albany, N. Y..... 467
bids for Jerome Park, N. Y..... 167
capacity of rapid sand 1910..... 47
capacity of rapid sand 1914..... 48
change of type of rapid sand..... 46
clogging of by acid waters..... 43
comparison of types of..... 153
comparative charges per 1,000,000 gallons for sand and mechanical... 155
comparative estimate of sand and mechanical for New York..... 154
comparative growth of slow and rapid sand..... 72
cost of operation of slow and rapid sand..... 70
cost of slow and rapid sand..... 69
cost, efficiency, simplicity of operation of slow sand..... 40
date of first plant..... 31
detail plans for mechanical for New York..... 158
details for design for Croton..... 162
early ones slow sand type..... 31
efficiency of at Pittsburgh, Pa..... 40
efficiency of at Washington, D. C..... 36
first in United States at Poughkeepsie, N. Y..... 31
first rapid sand at Somerville, N. J., 1885..... 45
household, efficiency of in Chicago..... 589
household, functions of..... 590
household, types of..... 590
mechanical sand washing at Wilmington, Del..... 129
operation of, not always good..... 29
percolating in sewage disposal..... 369
population of United States supplied by slow and rapid sand..... 74
population supplied by rapid sand in 1910..... 47
population supplied by rapid sand in 1914..... 48
questions concerning mechanical for New York..... 156
questions concerning sand for New York..... 157
rapid sand at Cincinnati, Ohio..... 54
rapid sand at Columbus, Ohio..... 57
rapid sand at Little Falls, N. J..... 46
rapid sand at Louisville, Ky..... 56
rapid sand at New Orleans, La..... 50
rapid sand built in United States 1885–1910..... 47
rapid sand built in United States 1910–1913..... 48
relative hygienic efficiency of slow and rapid sand..... 71
results of operation at Cincinnati of..... 55

Filters, results of operation of at Columbus, Ohio..... 58
results of operation of at Little Falls, N. J..... 49
results of operation at Louisville..... 57
results of operation at New Orleans..... 54
slow sand at Albany, N. Y..... 33
slow sand at Lawrence, Mass..... 32
slow sand at Philadelphia, Pa..... 37
slow sand at Pittsburgh, Pa..... 39
slow sand at Washington, D. C..... 34
turbidity limit of slow sand..... 38
typhoid death rate before and after introduction of sand..... 72
Filtration as affecting red water troubles..... 67
Filtration at Wilmington, Del..... 116
chemicals for at New York..... 160
distribution of population supplied by sand..... 76
first recognized as means of reducing disease..... 31
growth of rapid sand in United States..... 45
growth of slow sand in United States..... 32
objection to use of chemicals in..... 58
opposition to, of Croton water..... 168
population supplied by slow sand in 1914..... 32
present day practice of..... 31
relative cost of slow and rapid sand processes of..... 68
slow sand in United States..... 44
slow sand plant at Wilmington, Del..... 121
typhoid reduced at Philadelphia by..... 37
Filtration in other countries..... 519, 520
Fire Alarm Attachment for Recording Pressure Gage. Paper by W. E. Haseltine..... 551
Fire lines, metering of, some remarks relative to..... 275
Fire losses, record of..... 652
Fire protection, cost in Wisconsin cities..... 96
fixing prices for..... 540
methods of computing compensation for..... 98
methods of apportioning cost of..... 95
method of determining cost of..... 96
payment for upkeep of hydrants..... 99
payment per miles of pipe for..... 99
per cent cost of..... 95
per cent total investment necessary for..... 101
pipe capacity unit basis for cost of..... 99
price per hydrant illogical..... 97
value of per capita..... 540
Fire service, private, information relative to..... 310–319
public, information relative to..... 298–309
Fire services, charges for..... 682
Fixing prices for fire protection..... 540
Foreword..... 1

FORTY-EIGHT INCH CAST IRON FORCE MAIN FOR ATLANTIC CITY, N. J. Paper by L. Van Gilder 704
Free chlorine, ortho-tolidin test for 734
Free water, remarks concerning 249
Freeport, Ill., determination of water works value at 101
Gages, use and benefit of pressure recording 103
used for testing hydrants 544
Gelatine, advisability of substituting agar for in determining bacterial counts 11
Gelatine and agar, comparison of 13–16, 526
Grand Rapids, Mich., rapid sand filter 472
GRAVITY WATER SUPPLY AT THE CITY OF MANILA, PHILIPPINE ISLANDS. Paper by H. E. Keeler 338
Great Lakes, remedies for sewage pollution of 24
Grit chambers 364
Ground water supplies, growing value of 715
rain fall available for 715
uncertain capacity of 715
GROWING VALUE OF GROUND WATER SUPPLIES, THE. Paper by L. J. LeConte 715
Hamburg, cholera epidemic in 1892 31
Hot water boilers, care of when water turned off 668
HOUSE TO HOUSE INSPECTION. Paper by A. Prescott Folwell 685
Household filters, efficiency of in Chicago 589
Hyatt, Isaiah S., granted filter patent in 1884 31
Hydrant rentals, advantages of inch foot method of determining 100
found insufficient by Wisconsin commission 95
inch foot of diameter basis for estimating 100
not proper method for paying for fire protection 539
price per hydrant illogical 97
Hydrants, equitable rentals for 95
false economy in ordering 529
payment for upkeep of 99
Hypochlorite, limitation of water treatment by 186
use with Croton water 150
INDIVIDUALITY OF PUBLIC UTILITIES, NOTABLY WATER WORKS. Paper by W. E. Miller 614
discussion by A. A. Reimer 696
Inspections, house to house 685
INVESTIGATION INTO THE ADVISABILITY OF SUBSTITUTING AGAR FOR GELATINE AS A MEDIUM FOR THE DETERMINATION OF BACTERIAL COUNTS IN WATER ANALYSIS. Paper by W. U. C. Baton 11
LABORATORY CONTROL OF WATER SUPPLIES. Paper by Edward Bartow .. 720
Lawrence, Mass., slow sand filters at 32
Lead lined pipe, experience with 648
LEGAL DECISION IN A WATER SUPPLY POLLUTION CASE. Paper by J. Walter Ackerman 688
discussion by Nicholas S. Hill, Jr. 692
J. Walter Ackerman 693

Liquid chlorine, advantage of over chloride of lime 439
compared with bleach 420
description of apparatus 419
efficiency of at Philadelphia 425
experience with at Torresdale 403
experience with at Wilmington, N. C 418
experience with at Belmont Filter plant 416
first complete results 416
first permanent plant in Philadelphia 418
historical sketch of use of in the United States 415
introduction of by Major Darnell 415
objection to use of 443
original apparatus and changes thereto 419
reactions of 441
results from treatment 420
List of illustrations vii
Little Falls, N. J., rapid sand filters at 46
London, first filter plant erected at 31
Louisville, early investigation of filtration at 56
rapid sand filters at 56
Management, factors entering into water works 695
undeveloped field in water works 694
Manila, gravity water supply at 338
Media, different kinds used 523
Members deceased 4, 193
Members elected 3, 189
Membership, statement of 5, 193
Metered service, information relative to 260, 274
Metering of fire lines, some remarks relative to 275
Meters, annoying noises caused by 657
average life of 676
averaging rates 662
best way of testing 657
cost of reading 675
effect on cost of water to consumers 637
experience with straight line reading 657
on water used for construction 683
possibility of over registration 663
repairs of 678
should they register cubic feet or gallon 667
who pays cost of 638
Montreal, Canada, largest slow sand filter 471
use of liquid chlorine 438
Mortality statistics at Cincinnati, Ohio 487
Mortality statistics at Rhode Island 502
New Orleans, rapid sand filters at 50
water and sewer connections at 53
New York, design of filter plant for 153

New York, typhoid fever in 146
New York section, constitution of 8
minutes of the meeting of 7
Niagara River, pollution of 28
Nitrite test, use in determining source of pollution of a water supply 602
NOTE ON ORTHO-TOLIDIN TEST FOR FREE CHLORINE. Paper by W. F. Montfort 734
NOTES ON THE CONTAMINATION OF A DRINKING AND RAILROAD WATER SUPPLY BY SEA WATER, AND THE REMOVAL OF THE SALT WATER FROM THE RESERVOIR. Paper by John R. Downes 709
Odors, removed by ozonization 632
Officers 1914, 1915 ..... June II
Ortho-tolidin, action of chlorine an oxidizing agent on 734
test for free chlorine 734
Ozone, effect on algae growth 629
Ozonization for removal of odors 632
Ozonization of water abroad 632
Pavements, temporary repairs to 650
Percolating filters in sewage disposal 369
Philadelphia, before filtration installed 498
slow sand filters at 37
Pipe capacity unit, basis for fire protection for 99
Pipes, electrolytic action on 250–259
Pitot tube, theory of 81, 536
Pittsburgh, Pa., filters at 39, 467
use of chemicals with slow sand filters at 43
Pollution of boundary waters by sewage 25
Pollution by salt water 709
Pollution of Croton water 143
Pollution of water supply determined by use of nitrite test 602
Pollution, installation of filter plant does not guarantee safety 29
Pollution, legal decision in water supply case 688
Pollution of St. Clair, Detroit and Niagara Rivers 28
Poughkeepsie, N. Y., erection of first filters at 31
PRESENT DAY WATER FILTRATION PRACTICE. Paper by George A. Johnson 31
discussion by J. W. Armstrong 497
C. B. Buerger 492
C. B. Burdick 505
J. M. Caird 483
J. N. Chester 481, 506
J. A. Dallyn 504
H. F. Dunham 506
J. W. Ellms 487
G. W. Fuller 490
J. H. Gregory 466
Paul Hansen 505
W. C. Hawley 477

PRESENT DAY WATER FILTRATION PRACTICE—*Continued*
discussion by H. C. Hodgkins..... 506
G. A. Johnson (author's closure)..... 509
T. A. Leisen..... 494
P. A. Maignen..... 476
R. E. Milligan..... 500
J. C. Trautwine..... 498
R. S. Weston..... 494
G. C. Whipple..... 474
Pressure recording gages, as indication of condition of pumps..... 104
benefit of..... 107
check on firemen..... 105
early recognition of value of..... 103
how installed..... 106
in the pumping station..... 103
incentive to better firing..... 104
location of..... 106
on distribution system..... 106
preservation of charts..... 108
use and benefit of..... 103
use of portable..... 107
ways useful..... 110
Pressure recording gage charts, story told by..... 109
Private fire services, charges at Freeport, Ill..... 102
control of..... 655
information relative to..... 310–319
Private service lines, information relative to..... 320–337
Proportioning concrete..... 353
Public fire service, information relative to..... 298–309
PURIFICATION OF WATER BY ULTRA VIOLET RAYS. Paper by M. von Recklinghausen..... 565
discussion by S. T. Powell..... 585
B. F. Shaw..... 586
M. von Recklinghausen..... 586
Purification of water, factor in typhoid reduction..... 733
PUSHING SERVICE PIPES UNDER PAVEMENTS. Paper by F. C. Amsbary.. 719
Queen Lane filter plant..... 431
Question box..... 637
Question 1. Do meters increase or decrease cost of water supply to consumers..... 637
discussion by C. F. Barrett..... 638
H. P. Bohmann..... 637
J. N. Chester..... 637
E. E. Davis..... 638
A. A. Reimer..... 637
W. J. Wills..... 638

Question Box—*Continued*
Question 2. How is the cost of installation and maintenance of meters borne? ... 638
discussion by J. D. Barnett ... 643
C. F. Barrett ... 639
H. P. Bohmann ... 639, 644
Oscar Bulkeley ... 644
J. N. Chester ... 639
G. F. Cooper ... 640
E. E. Davis ... 639, 647
Robert Elliott ... 644
C. Faller ... 640
Patrick Gear ... 643
W. C. Hawley ... 642
H. C. Hodgkins ... 639, 640
H. Hymmen ... 640
C. McFarland ... 641
J. O'Shaughnessy ... 645
E. E. Parker ... 643
G. Shoemaker ... 645
L. L. Tribus ... 645
C. W. Wiles ... 639, 640
W. J. Wills ... 639
Question 3. Experience with lead or tin lined pipe; comparative efficiency, life and cost? ... 648
discussion by J. M. Diven ... 649
P. Gear ... 649
C. S. Potter ... 650
R. J. Thomas ... 650
Question 4. What is the best method of making temporary repairs to pavements torn up for construction or repairs, putting in services, etc ... 650
discussion by H. P. Bohmann ... 650
Oscar Bulkeley ... 651
J. M. Diven ... 650, 651
M. R. Sherrerd ... 651
Question 5. Should private fire services be shut off in case of fire sprinkler protected buildings, as soon as the fire department reaches the fire and is in action? ... 652
discussion by H. P. Bohmann ... 652
J. M. Diven ... 655
P. Gear ... 656
W. H. Randall ... 656
C. H. Smith ... 652-656
Question 6. Experience with annoying noises caused by working of water meters? ... 657
discussion by H. P. Bohmann ... 657
A. A. Reimer ... 657

Question Box—*Continued*
Question 7. What is the correct or best way of testing water meters? Is it practical to test meters in place? ... 657
discussion by H. P. Bohmann ... 657
W. Volkhardt ... 657
Question 8. Experience with straight line reading meters, are they preferable to clock dial meters? ... 657
discussion by J. D. Barrett ... 658
H. P. Bohmann ... 658
Thomas Hodkinson ... 661, 662
G. Houston ... 659, 660
E. W. Kelly ... 660
C. S. Potter ... 662
W. H. Randall ... 659, 660, 662
A. A. Reimer ... 661, 662
W. Volkhardt ... 658
C. W. Wiles ... 659
W. J. Wills ... 660
W. R. Young ... 658
Question 9. Legal decisions concerning "average rate" when meter is out of order and not registering? ... 662
discussion by R. A. Jackson ... 663
C. S. Potter ... 662
Question 10. Possibility of and conditions governing over registration of meters ... 663
discussion by J. D. Barnett ... 663
H. P. Bohmann ... 663
A. W. Cuddeback ... 666
J. M. Diven ... 664
P. Gear ... 663
W. Luscombe ... 665
C. S. Potter ... 665
W. H. Randall ... 665
A. A. Reimer ... 667
W. Volkhardt ... 666
C. W. Wiles ... 664
W. J. Wills ... 665, 666
Question 11. Should meters register cubic feet or gallons? ... 667
discussion by J. M. Diven ... 667
A. P. Folwell ... 667
W. Luscombe ... 668
A. A. Reimer ... 668
C. W. Wiles ... 667
Question 12. How should house hot water boilers be cared for when water is shut off; what instructions should be given to occupants of houses? ... 668
discussion by H. P. Bohmann ... 668
J. E. Brooks ... 670

Question Box—*Continued*
Question 12—*Continued*
discussion by J. Caulfield.... 670, 671
J. M. Diven.... 668, 670
P. Gear.... 669, 670
E. W. Henry.... 670, 671
W. H. Peck.... 669
P. Walsh.... 671
Question 13. Do you use check valves on metered services, if so why and what benefit do you derive from them?.... 671
discussion by H. P. Bohmann.... 671
J. Caulfield.... 671
A. W. Cuddeback.... 672
E. E. Davis.... 674
P. Gear.... 673
W. Luscombe.... 671
W. D. Pollard.... 674
W. H. Randall.... 673
A. A. Reimer.... 671
W. Ross.... 673
R. J. Thomas.... 671
L. L. Tribus.... 673
W. R. Young.... 672
Question 14. Has any water department or water company ascertained what it costs per consumer to read, make out and collect bills?.... 675
discussion by John Caulfield.... 675
W. S. Cramer.... 675, 676
J. M. Diven.... 676
W. Luscombe.... 675
M. R. Sherrerd.... 676
Question 15. What is the average life of a water meter, especially the smaller size—five-eighths to one inch? Has any one any experience in regard to this.... 676
discussion by H. P. Bohmann.... 676
P. Gear.... 677
G. Houston.... 676
W. Luscombe.... 677
A. A. Reimer.... 676
Question 16. Which is better to maintain, a meter repair department, or send meters to the manufacturers when repairs are needed, especially in the case of small water works?.... 678
discussion by H. P. Bohmann.... 678
W. S. Cramer.... 678
G. Houston.... 679
G. A. Main.... 678
C. W. Wiles.... 678
W. J. Wills.... 678
W. R. Young.... 678

Question Box—*Continued*
Question 17. What is the responsibility of a water company or department for damages caused by bursting water mains?.. 680
discussion by H. P. Bohmann..... 680
J. M. Diven..... 680
W. H. Randall..... 680
W. R. Young..... 680
Question 18. It is a well known fact that when a thaw begins, and the frost goes out of the surface of the ground there is increased trouble from frozen underground pipe; can any one explain or give cause of this trouble?..... 681
discussion by P. Gear..... 681
M. R. Sherrerd..... 681
Rapid sand filters, average cost of..... 473
at Cincinnati..... 473
at Grand Rapids, Mich..... 472
at Toledo, Ohio..... 472
Recording gages, use and benefits of..... 103
Red water, study of in Croton supply..... 162
Red water question..... 66
REMARKS ON THE THEORY ON THE PITOT TUBE. Paper by N. W. Akimoff.. 81
discussion by J. W. Ledoux..... 536
Repairs to pavement..... 650
Reports of Committees
Electrolysis..... 217
Finance..... 214
National Bureau or Department of Health..... 200
Permanent Headquarters..... 199
Publication..... 218
Standard Specifications for Cast Iron Pipe and Specials..... 220
Standard Specifications for Hydrants and Valves..... 217
Standard Specifications Wrought Iron Pipe..... 225
Tabulation of Rates and Other Information..... 201, 231
Water Consumption..... 215
Report of Treasurer..... 213
Rhode Island mortality statistics..... 502
Roxboro filter plants..... 431
Salt water, pollution of water supply by..... 709
Sand, tests for..... 353
used in concrete work..... 352
Sand filtration, not becoming obsolete..... 474
Sanitary survey of water shed of Great Lakes..... 24
Schedule of water rates..... 233–243
Screens, types of used in sewage disposal..... 364
Sections, minutes of New York..... 7
Service lines, private information relative to..... 320–337
Service pipes, cleaning..... 649
pushing under pavement..... 719

Sewage disposal, advancement in..... 361
Sewage disposal, at Philadelphia..... 375, 382
American conditions..... 360
contact beds..... 369
European conditions..... 360
grit chambers..... 364
lessons from study of European conditions..... 374
notable works..... 373
percolating filters..... 369
relation to water supply..... 363
river fronts..... 374
screens..... 364
tanks..... 367
SEWAGE POLLUTION OF BOUNDARY WATERS. Paper by Allan J. McLaughlin, M.D..... 24
discussion by Edward Bartow..... 529
J. M. Caird..... 532, 534
F. A. Dallyn..... 529, 530, 533
J. M. Diven..... 528
C. Faller..... 532
F. C. Kimball..... 531
F. W. Langstroth..... 531, 534
Alexander Potter..... 535
S. G. Powell..... 534
G. R. Taylor..... 532
Sewers, in ancient cities..... 359
Slow sand filters, largest at Montreal..... 471
little advancement in construction features in this country..... 483
Slow sand filtration, growth of in United States..... 32
Sludge disposal..... 371
SOME OBSERVATIONS OF THE EFFECT OF OZONE ON ALGAE GROWTHS. Paper by S. T. Powell..... 629
SOME RELATIONS BETWEEN THE WATER SUPPLY AND TYPHOID FEVER IN WASHINGTON, D. C. Paper by John Gaub..... 727
Source of water supply, etc., information relative to..... 276–297
Sprinklers, quantity of water used by..... 654
St. Clair River, not safe for water supply..... 27
St. Lawrence River, seasonal pollution of..... 28
Sterilization of water by liquid chlorine, historical sketch of in United States..... 415
Storage reservoir, catchment of..... 715
Superintendents' day made permanent feature of conventions..... 226
Table of contents.....
Tabulation of rates and other information of interest to water works..... 233
Tanks, types used in sewage disposal..... 367
Test plug for water mains..... 717
TESTING OF CHECK VALVES. Paper by J. Walter Ackerman..... 90
discussion by J. W. Ackerman..... 546, 547

TESTING OF CHECK VALVES—*Continued*
discussion by F. A. Dallyn..... 547
E. E. Davis..... 548
George Houston..... 546
Tests for concrete work..... 346
Tests for sand..... 353
Toledo, Ohio, rapid sand filter..... 472
Torresdale filter plant at Philadelphia..... 38
analytical tests..... 406
description of bleach plant..... 405
historical sketch of..... 403
location of..... 468
Treasurer's report..... 213
Typhoid death rates before and after treatment by slow and rapid sand filtration..... 72
Typhoid fever, at Elmira, N. Y..... 485
discovery of as specific disease..... 31
in New York..... 146
prevalance of in winter and spring months..... 24
rate in American cities..... 148
relations in Washington, D. C., with water supply..... 727
statistics at Wilmington, Del..... 114
Ultra violet rays, bacterial power of..... 570
condition of water for treatment..... 582
development of apparatus..... 574
installations of apparatus..... 580
operating cost..... 584
physical characteristics..... 569
principle of..... 567
purification of water by..... 565
quantitometry of..... 572
source of..... 567
Underground sewers of ancient construction..... 359
AN UNDEVELOPED FIELD IN WATER WORKS MANAGEMENT. Paper by Paul Hansen..... 694
USE AND BENEFITS OF PRESSURE RECORDING GAGES. Paper by J. M. Diven..... 103
discussion by J. Walter Ackerman..... 550
J. M. Diven..... 549, 550
A. A. Reimer..... 549
USE OF CONCRETE IN WATER WORKS CONSTRUCTION. Paper by Edgar B. Kay..... 345
USE OF THE NITRITE TEST IN DETERMINING THE SOURCE OF POLLUTION OF A WATER SUPPLY. Paper by William Miller Booth..... 602
discussion by J. M. Caird..... 611
S. T. Powell..... 611
Value of pressure recording gages..... 103

WANDERER'S NOTES ON FOREIGN WATER SUPPLIES, A. Paper by Louis L. Tribus.... 384
Washington, D. C., efficiency of filters at.... 36
filter plant at.... 34, 484
typhoid reduction by filtration at.... 37
Water, American standard of purity low.... 135
effect on filters of acid.... 43
pollution of Croton.... 143
purification of, factor in reducing typhoid.... 733
quantity used by automatic sprinklers.... 654
question of red.... 66
reasons for coagulation of.... 58
sterilization of by liquid chlorine, historical sketch of in the United States.... 415
surface supplies not safe without treatment.... 29
Water analysis, advisibility of substituting agar for gelatine.... 11
agar adopted for medium for bacterial, by Am. Pub. Health Assn.... 11
Water mains, responsibility for damage by bursting.... 680
test plug for.... 717
Water purification, at Washington, D. C.... 484
balanced with sewage treatment.... 29
Water rates, effect of meters on.... 637
penalties for non-payment of.... 682
schedule of.... 233-243
Water shed protection, cost of.... 172
Water supplies, growing value of ground.... 715
laboratory control of.... 720
Water supply, source of information relative to.... 276-297
Water supply pollution, discussion.... 692
Water borne diseases, discovery of.... 31
typhoid and cholera.... 31
Water works construction, concrete in.... 345
Water works management, factors entering into.... 695
an undeveloped field in.... 694
Water works topics, general discussion of.... 682
THE WATER SUPPLY OF WILMINGTON, DEL. Paper by Edgar M. Hoopes and James M. Caird.... 111
Water-proof concrete.... 356
Wilmington, Del., bacterial results at.... 117, 125
mechanical sand washing at.... 130
new water works at.... 113
preliminary filters at.... 116
pumping station at.... 118
results of hypo and chlorine treatment.... 437
sedimentation reservoir at.... 119
slow sand filter plant at.... 121
turbidity of water at.... 118

Wilmington, Del., typhoid statistics at 114, 118
water supply at 111
Wilmington, N. C., experience with bleach and liquid chlorine 434
filter plant 434
water conditions 434
Wisconsin water plant, per capita valuation 625
physical valuation 626
pumping capacity valuation 626
tabulation of 617

AUTHORS' INDEX

ACKERMAN, J. WALTER, paper, LEGAL DECISIONS IN WATER SUPPLY POLLUTION CASE 688
paper, TESTING OF CHECK VALVES 90
discussion, disinfecting at Torresdale 450
legal decisions in pollution case 693
testing of check valves 546, 547
use of recording gage 550
AKIMOFF, N. W., paper, REMARKS ON THEORY OF PITOT TUBE 81
ALVORD, JOHN W., foreword 1
paper, EQUITABLE HYDRANT RENTALS AND BETTER METHODS FOR APPORTIONING FIRE PROTECTION COSTS 95
discussion, equitable hydrant rentals 699, 700, 702, 703
AMSBARY, F. C., paper, PUSHING SERVICE PIPES UNDER PAVEMENTS 719
ARMSTRONG, J. W.
discussion, present day filtration 497
BACHMAN, FRANK, paper, EFFICIENCY OF HOUSEHOLD FILTERS IN CHICAGO 589
BARNETT, J. DAVIS,
discussion, equitable hydrant rentals 697
Question 2 643
Question 8 658
Question 10 653
BARRETT, C. F.
discussion Question 1 638
Question 2 639
BARTOW, EDWARD, paper, LABORATORY CONTROL OF WATER SUPPLIES 720
discussion, sewage pollution of boundary waters 529
BATON, W. U. C., paper, INVESTIGATION INTO THE ADVISABILITY OF SUBSTITUTING AGAR FOR GELATINE AS A MEDIUM FOR THE DETERMINATION OF BACTERIAL COUNTS IN WATER ANALYSIS 11
discussion, disinfecting at Torresdale 523
BLANKENBURG, HON. RUDOLPH, address of welcome at Philadelphia 202
BLAUVELT, ALBERT
discussion, equitable hydrant rentals 699, 700
charges for fire services 682
BOHMANN, H. P.
discussion Question 1 637
Question 2 ..... 639, 644
Question 4 650
Question 5 652
Question 6 657
Question 7 657

BOHMANN, H. P.
discussion Question 8..... 658
Question 10..... 653
Question 12..... 668
Question 13..... 671
Question 15..... 676
Question 16..... 678
Question 17..... 680
BOOTH, WILLIAM MILLER, paper, USE OF THE NITRITE TEST IN DETERMINING THE SOURCE OF THE POLLUTION OF A WATER SUPPLY..... 602
discussion, use of nitrite test..... 611
BROOKS, J. E.
discussion Question 12..... 670
BUERGER, CHARLES B.
discussion, present day filtration..... 492
BULKELEY, OSCAR
discussion, equitable hydrant rentals..... 697, 702
water used for construction..... 683, 684
Question 2..... 644
BURDICK, CHARLES B.
discussion, present day filtration..... 505
CAIRD, JAMES M., paper, THE WATER SUPPLY AT WILMINGTON, DEL..... 111
discussion, Croton water supply..... 180
present day filtration..... 483
use of nitrite test..... 611
sewage pollution boundary water..... 532, 534
CAPPELEN, F. W.
discussion, conservation of potable water..... 563
Question 12..... 670, 671
Question 13..... 671
Question 14..... 675
CHESTER, J. N.
discussion, equitable hydrant rentals..... 545
conservation of potable waters..... 558
present day water filtration..... 481, 506
Question 1..... 637
Question 2..... 639
COOPER, G. F.
discussion, Question 2..... 640
CRAMER, W. S.
discussion, Question 14..... 675, 676
Question 16..... 678
CUDDEBACK, A. W.
discussion, Question 10..... 666
Question 13..... 672
DALLYN, F. A.
discussion, present day filtration..... 504
purification of water by ultra violet rays..... 585

DALLYN, F. A.
discussion, sewage pollution of boundary waters..... 529, 530, 533
testing of check valves..... 547
DATESMAN, GEORGE E., paper, BRIEF REVIEW OF SEWAGE DISPOSAL WORKS IN SOME EUROPEAN CITIES AND COMPARISON WITH THE PENNYPACK CREEK WORKS AT PHILADELPHIA..... 359
DAVIS, E. E.
discussion, testing of check valves..... 548
Question 1..... 638
Question 2..... 639, 647
Question 13..... 674
DIVEN, J. M., paper, USE AND BENEFIT OF PRESSURE RECORDING GAGES 103
discussion, conservation of potable waters..... 558, 560
Croton water supply..... 176
efficiency of household filters..... 600
sewage pollution of boundary waters..... 528, 529, 532
use of recording gages..... 549, 550
water used for construction..... 683, 684
Question 3..... 49
Question 4..... 650, 651
Question 5..... 655
Question 10..... 664
Question 11..... 667
Question 12..... 668, 670
Question 13..... 676
Question 17..... 680
DOWNES, JOHN R., paper, NOTES ON THE CONTAMINATION OF A DRINKING AND RAILROAD WATER SUPPLY BY SEA WATER AND REMOVAL OF THE SALT WATER FROM THE RESERVOIR..... 709
DUNHAM, H. F.
discussion, present day filtration..... 506
ELLIOTT, ROBERT
discussion, Question 2..... 644
ELLMS, J. W.
discussion, present day filtration (by letter)..... 487
FALLER, C.
discussion, sewage pollution of boundary waters..... 532
Question 2..... 640
FOLWELL, A. PRESCOTT, paper, HOUSE TO HOUSE INSPECTION..... 635
discussion, Question 11..... 667
FRENCH, D. W.
discussion, Croton water supply..... 175
FULLER, GEORGE W., paper, THE CROTON WATER SUPPLY; ITS QUALITY AND PURIFICATION..... 135
discussion, Croton water supply..... 463
present day filtration (by letter)..... 490
GAUB, JOHN, paper, SOME RELATIONS BETWEEN THE WATER SUPPLY AND TYPHOID FEVER IN WASHINGTON, D. C..... 727

GEAR, PATRICK
discussion, Question 2 643
Question 3 649
Question 5 656
Question 10 663
Question 13 673
Question 18 681
GREGORY, JOHN H.
discussion, present day filtration 466
HALE, FRANK E.
discussion, Croton water supply 179
HANSEN, PAUL, paper, AN UNDEVELOPED FIELD IN WATER WORKS MANAGEMENT 694
discussion, present day filtration 505
HASELTINE, W. E., paper, A CHEAP HOMEMADE TEST PLUG FOR WATER MAINS 717
paper, FIRE ALARM ATTACHMENT FOR RECORDING PRESSURE GAGES .. 541
HAWLEY, W. C.
discussion, equitable hydrant rentals 541, 700
present day water filtration 477
Question 2 642
HAZEN, ALLEN W.
discussion, Croton water supply 180
HENRY, E. W.
discussion, Question 12 669
HILL, NICHOLAS S., JR.
discussion, Croton water supply 177
water supply pollution case 692
HODGKINS, H. C., paper, CONSERVATION OF POTABLE WATER AND THE DUAL SYSTEM OF DISTRIBUTION 554
discussion, conservation of potable water 560, 564
equitable hydrant rentals 698
present day filtration 506
Question 2 ..... 639, 640
HODKINSON, THOMAS
discussion, Question 8 661
HOOPES, EDGAR N., paper, THE WATER SUPPLY AT WILMINGTON, DEL 111
HOUSTON, GEORGE
discussion, testing of check valve 546
Question 8 ..... 656, 660
Question 15 676
Question 16 679
HUY, H. F.
discussion, disinfecting water at Torresdale 451
HYMMEN, H.
discussion, Question 2 640
JACKSON, D. D.
discussion, conservation of potable waters 561

JACKSON, R. A.
discussion, Question 9..... 663
JENNINGS, C. A.
discussion, disinfecting at Torresdale..... 453
JOHNSON, GEORGE A., paper, PRESENT DAY WATER FILTRATION PRACTICE..... 31
discussion, Croton water supply..... 182
disinfecting at Torresdale..... 454
present day filtration (author's closure)..... 509
JOHNSON, R. F.
discussion, collection of water rates..... 683
KAY, EDGAR B., paper, THE USE OF CONCRETE IN WATER WORKS CONSTRUCTION..... 345
KEELER, H. E., paper, GRAVITY WATER SUPPLY AT MANILA, P. I..... 335
KELLY, E. W.
discussion, Question 8..... 660
KIMBALL, F. C.
discussion, conservation of potable waters..... 562
sewage pollution of boundary waters..... 531
LANGSTROTH, F. W.
discussion, conservation potable waters..... 561
sewage pollution of boundary waters..... 531, 534
LECONTE, L. J., paper, THE GROWING VALUE OF GROUND WATER SUPPLIES..... 715
LEDOUX, J. W.
discussion, the theory of the pitot tube..... 536
LEDERER, ARTHUR, paper, EFFICIENCY OF HOUSEHOLD FILTERS IN CHICAGO 589
LEISEN, THEODORE
discussion, present day filtration..... 494
LUSCOMBE, WILLIAM
discussion, Question 10..... 665
Question 13..... 671
Question 14..... 675
Question 15..... 677
MAIGNEN, P. A.
discussion, conservation of potable waters..... 561, 564
present day filtration..... 476
MAIN, GEORGE A.
discussion, non-payment of water bills..... 682
Question 16..... 678
MASON, DR. W. P.
discussion, Croton water supply..... 176
MCFARLAND, C.
discussion, Question 2..... 641
MCLAUGHLIN, ALLAN J., paper, SEWAGE POLLUTION OF BOUNDARY WATERS 24
MILLER, W. E., paper, DIAGRAMMATIC METHOD OF DETERMINING COST PER FOOT OF CAST IRON PIPE..... 612
paper, INDIVIDUALITY OF PUBLIC UTILITIES, NOTABLY WATER WORKS 614

MILLIGAN, R. E.
discussion, present day filtration..... 500
MONTFORT, W. F., paper, NOTE ON ORTHO-TOLIDIN TEST FOR FREE CHLORINE..... 734
discussion, efficiency of household filters..... 601
disinfecting at Torresdale..... 446
PARKER, E. E.
discussion, Question 2..... 643
PECK, W. H.
discussion, Question 12..... 669
POLLARD, W. D.
discussion, Question 13..... 674
POTTER, ALEXANDER
discussion, Croton water supply..... 456
equitable hydrant rentals (by letter)..... 538
sewage pollution of boundary waters (by letter)..... 535
POTTER, C. S.
discussion, Question 3..... 650
Question 8..... 662
Question 9..... 662
Question 10..... 665
POWELL, S. T., paper, SOME OBSERVATIONS OF THE EFFECT OF OZONE ON ALGAE GROWTHS..... 629
discussion, efficiency of household filters..... 601
sewage pollution of boundary waters..... 534
purification by ultra-violet rays..... 585
use of nitrite test..... 611
RANDALL, W. H.
discussion, sewage pollution of boundary waters..... 529, 535
Question 5..... 656
Question 8..... 659, 660, 662
Question 10..... 665
Question 13..... 673
Question 17..... 680
RECTOR, F. L.
discussion, efficiency of household filters..... 600
REIMER, A. A.
discussion, equitable hydrant rental..... 698
individuality of public utilities..... 696
use of recording gages..... 549
water used for construction..... 684
Question 1..... 637
Question 6..... 657
Question 8..... 661, 662
Question 10..... 667
Question 11..... 668
Question 13..... 671
Question 15..... 676

Ross, William
discussion, Question 13 673
Shaw, B. F.
discussion, purification by ultra-violet rays 586
Sherrerd, Morris R.
discussion, Question 4 651
Question 14 676
Question 18 681
Shoemaker, G.
discussion, Question 2 645
Smith, Charles H.
discussion, shutting off sprinklers 652-655, 656
Taylor, George R.
discussion, sewage pollution of boundary waters 532
Thomas, Robert J., address 1914 convention 205
discussion, charges for fire services 682
testing of check valves 548
Question 3 650
Question 13 671
Trautwine, J. C.
discussion, present day filtration 498
Tribus, Louis L., paper, A Wanderer's Notes on Foreign Water Supplies 384
discussion, collection of water rates 683
Question 2 645
Question 13 673
Van Gilder, L., paper, Forty-eight Inch Cast Iron Force Main for Atlantic City, N. J. 704
Volkhardt, William
discussion, Question 7 657
Question 8 658
Question 10 666
von Recklinghausen, M., paper, Purification of Water by Ultra-Violet Rays 565
discussion, purification of water 586
Walsh, P.
discussion, Question 12 671
West, Francis D., paper, Disinfecting 200,000,000 Gallons of Water a Day; Experience with Chloride of Lime and Liquid Chlorine at Torresdale Filtration Plant 403
discussion, substituting agar for gelatine 523
Weston, Robert Spurr
discussion, present day filtration 494
disinfecting at Torresdale 448
Whipple, George C.
discussion, present day water filtration 474
disinfecting at Torresdale 455

WILES, C. W.
discussion, Question 2..... 639, 640
Question 8..... 659
Question 10..... 664
Question 11..... 667
Question 16..... 678
WILLS, WIRT J.
discussion, Question 1..... 638
Question 2..... 639
Question 8..... 660
Question 10..... 665, 666
Question 16..... 678
YOUNG, WILLIAM R.
discussion, Question 8..... 658
Question 13..... 672
Question 16..... 678
Question 17..... 680